ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

2000 ANNUAL REPORT

TO

ONTARIO AGRICULTURAL SERVICES
COORDINATING COMMITTEE

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1.0 EXECUTIVE SUMMARY

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Listed below are the main research needs identified by the four engineering subcommittees. Because the groups cover four quite different discipline areas, the recommendations are kept separate for easy reference. Several of the recommendations have been listed before, bit have not been adequately addressed to date. Some have been modified or have changed focus somewhat. New recommendations will be identified.

Research needs of greatest importance this year:

1.1 Food Engineering

1. Improved technologies for pasteurization, such as non-thermal processes, to reduce processing cost and to enhance nutritional and flavour quality, and shelf life. [Previous recommendation]

2. Baking and frying processes modelling to improve baked and fried products' quality. [Previous recommendation]

3. Image processing for inexpensive in-line methods for detection of glass pieces in glass containers, chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans. [Previous recommendation]

4. Development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.) to be used in supplements and in fortified foods. [Previous recommendation]

5. In-line sensors for microbial detection, moisture at high temperature for baked foods and dough properties. [Previous recommendation]

6. Raw material characterization for food product quality. [Previous recommendation]

7. Optimizing material handling in wine and beer industry. [Previous recommendation]

8. **By product utilization and waste management.** Producing value-added food and non-food products from the under utilised or waste material and finding economical ways to reduce water and air pollution generated by the food industry would be an advantage to the industry - therefore, more research in this area is required **[New]**

9. **Process development for new products for small processors.** Due to the rapid expansion of small food processors who has very little capital to invest in short term R&D and long term high risk research, there is a need for conducting research at public research institutions. These research institutions should focus on process and product

development suited for small processors and to produce small scale speciality products to increase the profit. Lack of research support would make the long term survival of these processors questionable. **[New Service Recommendation]**

1.2 Livestock Engineering

1. Development of Standards for the Construction of Manure Storage Structures and Manure Handling Systems: Full scale testing is needed to assess current construction techniques and their ability to produce **leakproof** manure storage structures and transfer systems. **[New]**

2. Measurement and improvement of air quality in livestock buildings: [Previous recommendation]

3. Measurement and prevention of corrosion and deterioration of agricultural building components: [Previous recommendation]

1.3 Rural Environment Engineering

10. To develop improved systems for applying manure to no-till, hay, and pasture land more accurately, cost effectively, with fewer odours and low risk of movement to tile drains. [Previous recommendation - modified]

11. To evaluate and quantify the impact of large livestock operations on the rural environment. [Previous recommendation - modified]

12. **To investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land**. This project involves an examination of various manure treatment options with the specific goal of reducing odour levels at the barn and storage. **[New Focus]**

13. To identify sources of microbiological and pathogen related water contamination in agricultural watersheds and put into perspective the various contributors. [Previous recommendation]

1.4 Crops Engineering

14. **Development of non-compacting field equipment** - Work is needed to reduce soil pressure caused by farm equipment. Research is needed to design new equipment or modify existing designs to reduce soil pressures for, manure & fertiliser spreaders, combines, grain buggies, etc. **[New]**

15. Development of new grain and forage processing (drying) systems [Previous recommendation]

16. Development of applicators to apply manure and bio-solids uniformly on the land at desired rates and odour control [Previous recommendation]

17. **Rural roads and transporting equipment safety** - Rural road farm and non-farm traffic is increasing. There are a number of safety issues that need to be addressed urgently by the public and private sector. Lack of visibility is a major cause of many accidents. **[New Service Recommendation]**

2.0 INDUSTRY / SECTOR SCAN

2.1 Food Engineering

2.1.1 Major accomplishments since last report

- **Post-harvest handling of horticultural crops** - Mr. Hugh W. Fraser (OMAFRA) spent 20% of his time on extension work dealing with this - including: forced-air cooling demonstrations and advice to growers; advice on reusable plastic shipping containers; cold storage troubleshooting, etc.

- **Vibration response of Mozzarella cheese at various fat and moisture contents for process monitoring and control** – Dr. G.S. Mittal and Dr. J. Zhang: The objective of this study was to analysis the relationships between vibration response of Mozzarella cheese of different fat and moisture contents and to find the feasibility of analyzing cheese composition for process monitoring and control. Mozzarella cheese samples with different fat and moisture contents were vibrated vertically on a vibration exciter through a range of frequencies from 10 to 1000 Hz. The frequency response was modeled by a single-degree-of-freedom Kelvin model. There were 3 resonance frequencies when cheese samples were vibrated. The first was around 200 Hz, second in 350-400 Hz range and third near 700 Hz. Natural frequency (ω_n), critical damping (C_c) and stiffness (K) increased linearly with fat content increase. ω_n, C_c and K reduced nonlinearly with moisture content increase. Models describing changes in these parameters with chemical composition could be used to monitor cheese composition using a sensor based on this concept.

- **Method and apparatus for electrically treating foodstuffs for preservation** – G. S. Mittal, S.Y. Ho, J.D. Cross and M.W. Griffiths: A US patent was assigned on this on July 25, 2000. A method and apparatus for electrically treating foodstuffs flowing through a treatment chamber with low energy, high voltage electrical pulses for non-thermal pasteurization and/or sterilization. Instant-charge-reversal electrical pulses are applied to a foodstuff located between two electrodes in a treatment chamber, each electrical pulse having a pulse width in a range from about 1 to 5 µs with vertically rising voltage to a peak followed immediately with a decreasing voltage through zero volt and continuing to a voltage peak of opposite polarity and rising vertically back to zero volt. The vertical pulses are very low energy (0.1 to 25 J/pulse) and the field strengths are in the range 15 kV/cm to 120 kV/cm. The apparatus uses an electrode arrangement including a cylindrical inner electrode and inner disc with the cylindrical electrode inserted through the hole in the disc. 25 claims were approved on this technology under this patent.

- **Pasteurization of raw skim milk by pulsed electric fields and antimicrobials** – K. Smith, G. S. Mittal and M.W. Griffiths: This was an investigation of the microbial inactivation in raw skim milk by pulsed electric field treatment and antimicrobials nisin and lysozyme. The innovative technology of using a high-voltage pulsed electric field (PEF) for pasteurizing milk offers advantages of low processing temperatures and low energy utilization, while inactivating pathogenic microorganisms especially when combined with other preservation methods. A 7.0 log reduction of microorganisms found in raw skim milk has been achieved through a combination of pulsed electric field treatment (80 kV/cm, 50 pulses) , mild heat (52□C) and addition of the natural antimicrobial peptides nisin (3000 IU/ml) and lysozyme (1000 μg/ml). The combination of PEF, mild heat and antimicrobials resulted in a much higher microbial inactivation than the sum of the individual reductions achieved from each treatment alone, indicating synergy. Varying the pH from 6.7 to 5.0 had no effect on microbial inactivation.

- **Comparative evaluation of edible coatings to reduce the fat uptake in deep-fat fried foods** – S. Albert, G.S. Mittal: Eleven different hydrocolloid materials including gelatine, gellan gum, a κ-carrageenan-konjac-blend, locust bean gum, methyl cellulose, microcrystalline cellulose, pectin, sodium caseinate, soy protein isolate, vital wheat gluten and whey protein isolate were chosen for investigation and compared for their film forming ability, their suitability for frying experiments and their water and fat transfer properties. Soy protein isolate, whey protein and methyl cellulose gave the best results and are very promising as coating materials for low fat fried food. The composite coatings provided >90% fat reduction were: soy-protein isolate + whey protein (99.8% ± 9.0% fat reduction), whey protein + sodium caseinate (95.6% ± 4.6%), whey protein + microcrystalline cellulose (93.6% ± 5.9%) and soy-protein isolate + whey protein (91.4% ± 6.6%). More work is needed to improve the water transfer properties of these films. Thus to reduce fat uptake in fried foods, a novel concept of composite coating was developed.

2.1.2 Current state of the industry

- **Down-sizing and consolidation** of Canadian and U.S. operations continue to impact the structure of many Ontario food processing companies. Due to regional and global trade agreements, the food industry in Ontario is facing **international competition**. This will require considerable readjustment, productivity improvement and enhancement in product quality and safety. There is a large emphasis on value-added aspect of food processing. Downsizing putting less emphasis on R & D and more on organization aspects. Resources in Engineering R & D are decreasing due to overhead cuts and profit oriented approach. Food engineers are leaving to other industries and consulting due to less job satisfaction.

- **Less competition** is being created due to merging as the number of owners are decreasing in each food sector. On the other hand, **Co-packing** is increasing where smaller food processors are processing foods for larger processors. For this reason and in general, small food processing companies are increasing in numbers. Employees at these companies are paid lower wages. Many small companies are producing specialized food products. Ethnic group food companies are also emerging to supply special food items to various communities.

However, these smaller processors are facing the followings: 1. Need of R&D on process and product development, 2. Need of whole infrastructure, 3. Compliance of processing facility sanitary, product safety, and labelling requirements as per USDA/FDA regulation for export, 4. Expansion of process lines to increase the output, 5. Developing process lines for multiple use or multiple products, and 6. Producing more and more value added foods. These factors increase the demand for research done by public institutions. NRC provides financial support for research projects conducted by small and medium size (less than 500 employee).

- **Education and training of workforce** to properly use modern technology is lacking in food industry compared to other industries such as automobile industry. Due to the use of newer technology a wide gap is created between technology and training of workers.

- **Nutritional issues** are important for the industry. **Nutraceuticals** are also being produced in Ontario, but progress is slow. Overall, Canada is behind USA in this respect. In fortification of food products, juices in particular, USA is leading due to advantages in regulations. Chemical analysis of nutraceuticals are needed as well as improved labelling regulations are required.

  Products (juice) fortified with nutraceuticals are being produced and fortification to more and more foods is on the horizon; however, the presence of active ingredients in these products is questionable. Therefore, there is a need for new processing methods such as cold processing to preserve the active ingredients while inactivating microorganisms.

- **Economic problems**: For export, Canadian processed food is more attractive due to low value of Canadian dollar. However, imported equipment, machinery and raw material are more costly.

- **Energy managements** are needed by process and equipment modifications to reduce processing cost.

2.1.3 Emerging issues

- **Safety and Quality:** Air quality in the plants is required to be maintained particularly where ovens are used. Discharging particles into air is becoming a problem. These particles are more harmful as they cause respiratory problems. Water quality for food processing is also becoming more critical. Effective use of water and reuse of wastewater are needed. Odour and wastes discharged from processing plants is also becoming a major concern.

  Sensors for quality attributes and food safety are needed to effectively produce products with consistently high quality and greater consumer acceptance. For this, rapid and in-line methods for food analysis and quality control are required.

- **Technological Challenge:** Computer-dependant technologies continue to be important within the industry. Advances in instrumentation, automation and software, vision systems, and wider implementation of HACCP related quality control systems are all leading to wider use of computer technology. Vision scan and x-ray devices are needed for bruise detection on fresh produce, proper baking of cookies, and detection of worms and blood spots in food products.

- **Neutraceutical Processing**: There seems to be interest in extracting neutraceuticals from soybean, tomato, hemp, etc. Appropriate separation technology is needed to extract active ingredients. Cold processing is required to avoid degradation of active ingredients. Research is also needed in purification and concentration of neutraceuticals.

- **Wine and beer Industry**: Due to the growth of wine and beer industry especially, microbreweries, in Ontario, there are research needs in process engineering area. Micro breweries, are facing some problems such as: how to be profitable, more needs in processing knowledge and expertise, and using old equipment that is less energy efficiency, and costs more to repair.

- **Byproduct Utilization and solid waste management**: Presently byproducts from many food industries are going for animal feeding. Research is needed to utilize the byproducts from corn, apple and grape processing industry.

  Economical disposal of wastes is becoming a problem as the land and waterways are limited around the processing plants and strict regulation is being imposed. Cheese whey, soy processing waste, liquid egg processing waste, food packaging materials are some of the major sources.

  Making value added products from the under utilised or waste material would be an advantage therefore, more research in this area is required.

2.2 Livestock Engineering

2.2.1 Major accomplishments since last report

- **Air Quality in Livestock Buildings:** - Air quality in livestock buildings (Univ. of Saskatchewan - 0.1 py (person years)).
  - Evaluation of floor applied mineral oil in reducing respiratory dust (Univ. of Alberta - 0.1 py)

- **Corrosion and Deterioration of Agricultural Building Components:** Corrosion and deterioration of agricultural building components (Univ. of Guelph 0.35 py)

- **Manure tank design:** Innovative design of manure storage tanks (Univ. of Manitoba - 0.54 py).
  - A letter to the Standing Committee on Structural Design pertaining to the wording of

the National Farm Building Code is proposed. This will be forwarded to the Standing Committee in 2001. As well, an emergency amendment to the Ontario Building Code will be made in 2001.

- **Animal Comfort:** - A behavioural and environmental study to develop improved gestation and farrowing accommodation for sows and litters (Lennoxville, Que - 2.0 py).
  - Using natural convection to lower attic temperatures in controlled environment buildings (Univ. of Manitoba - 0.08 py)
  - Low Energy Input Swine Housing Systems (Winnipeg, Manitoba - time unknown)

- **Corrosion of Roof Truss Gusset Plates** - Clarification and a letter of support from the Truss Plate Institute of Canada is forth-coming.

- **Technical Information for the Construction Industry:** Structural behaviour of nail-laminated posts (Univ. of Manitoba - 0.11 py)

2.2.2 Current state of the industry

- **Beef: - The Ontario beef industry is moving into a time of optimism and growth.**
  - The industry is consolidating and being directed by stronger hands.
  - The Ontario Cattle Feeders Association (approx. 3 years old) is showing a marked effect on the industry. Much of the cattle feeding is done on contract.

- **Dairy:** - Optimism in the industry remains.
  - The price of quota continues to rise – variable, but averaging $20,000/kg of butterfat.
  - Barns continue to be constructed, both by immigrant producers, and established producers.
  - Commercial robotic milking installations are becoming more common. A dozen or more farms are now operating exclusively with milking robots. Several companies are offering robots for sale: Lely, Prolion, Delaval, and Surge-Westfalia.

- **Swine: -** Barns continue to get bigger in size: 2400 sow barns and 2000 finishing barns are becoming the norm.
  - Society's reaction to proposed swine barns being built is becoming widespread.
  □□Municipalities are reacting with restrictive by-laws in an attempt to minimize 'large' barns.
  - Facilities with leaking manure tanks and manure transfer piping systems have been encountered.
- **Sheep and Goats: -** Sheep production is increasing slightly, some as milking herds.
  - There is a continued increased interest in goat operations.

- **Poultry: -** Producers continue to be very optimistic about this industry and seem prepared to invest big dollars in quota and new facilities. Interest continues to come from older dairy farmers who are switching between the two quota systems. Extremely high quota

prices continue (broilers @ $42/unit; egg quota @ $80+/hen; turkeys @ $2.60/kg).
□□Ontario has approximately: 1100 broiler producers; 200 pullet producers; 500 egg laying hen producers; and 160 turkey producers.

- **Fruit and Vegetables:** - The greenhouse industry continues to expand, particularly in the Leamington area (cucumbers and tomatoes) and in Niagara (flowers).
  - Non-traditional niche-market crops are being grown with unfamiliar post-harvest requirements.

- **Grains and Forages:** - Construction of tower silos remains at an all-time low.
  - Silo deterioration continues to be an ongoing challenge.
  - Plastic from wraps, tubes, individual bags, etc. present local problems for recycling or disposal.

- **Building Engineering:** - Snow loading concerns have surfaced in large farm buildings. The recent collapse of 10-12 large buildings has sparked interest in the design process used for farm roofs.
  - Building construction is still relatively active in Ontario. Typically, new livestock buildings are tending to be very large. Engineering is more prevalent in these larger structures. A larger contractor may have an on-staff engineer or may hire a private consultant to provide engineering details. Building officials are happy to share some of the responsibility for the structure with an engineer.
  - Municipal restructuring means fewer, better trained building officials. There are currently fewer than 500 municipal building officials serving rural areas. It is expected that there will be approximately 350 by 2003. This is bringing about more even application of building codes in Ontario. OMAFRA continues its education program, directed toward the improved application of building codes in Ontario.

- **Environmental:** - A large number of swine, poultry and dairy operations are still being constructed in Ontario. Nutrient Management Plans are commonly being required by municipalities. Farmers are anxiously awaiting the announcement of the proposed Agricultural Operations Act. Public interest groups are vocal against large livestock operations being constructed in their communities. Some municipalities have placed an interim control bylaw in effect to limit the construction of larger livestock operations until the Ag. Operations Act comes into being.

2.2.3 Emerging issues

- The use of safety railing around openings in manure tanks and transfer pumps need to be addressed.
- Recent building collapses due to significant snow loading has resulted in the need to rethink design methodology for farm roof construction. Require an improved, comprehensive design model to describe snow load distribution on large farm structures.
- Preventing manure leakage from barns and storages. Require full-scale building testing of

manure storage and handling components to prove or disprove the integrity of current building techniques.

- Manure handling problems when sand bedding is used in free-stalls
- Power-driven nails do not have the shear strength or holding power of spiral and common nails. Require information regarding the strength of nailed joints.
- Disease control on new large swine operations
- Covered manure storages for poultry
- More cold storages will be used year round to spread out costs. This may create some vapour barrier problems with reversing vapour pressure gradients.
- Need for improved aeration systems for flat grain storages.
- Producers believe there is a need for research to provide information and technology to prevent or alleviate concerns regarding animal welfare and environmental sustainability in all sectors.
- Questions still remain regarding the use/operation of tunnel ventilation systems. Require information regarding the factors that affect tunnel ventilation.
- What depth of manure storage under a barn floor is acceptable?
- Time commitment, and type of cleaning equipment being recommended for cleaning barns between animal cycles. There is some speculation on the use of robotics for this task
- Require development of comprehensive standards for all aspects of manure storage and handling.
- Investigate the use of a spray bar to reduce H_2S development in tanker or manure tank
- Further research is needed to measure and improve mixing accuracy of medicated feeds, low energy rations, etc.
- Require increased odour control research for both inside barn air quality as well as around the buildings.
- Beef producers need to be able to lower costs of production by 20%. Simplified structures would assist. Some features might be modular construction, a roll-off roof, combination manure systems.

2.3 Rural Environment Engineering

2.3.1 Major accomplishments since last report

- **Educational Courses**
  - Primary Drainage Contractors Course, Feb. 2000
  - Advanced Drainage Contractors Course, March 2000
  - Municipal Officials Drainage Course - Apr. 2000
  - Concrete Manure Storage Design Course, 2000
  - Custom Manure Application Course, 2000
  - Pollution Control Course, 2000
  - Drainage Superintendents Course, 2000
  - Nutrient Management Sessions - 2000 (several)
  - Ontario Environmental Farm Plan - 2000 All Ontario.

- **Other** - Ontario Rural Wastewater Centre, University of Guelph School of Engineering and Alfred College.

2.3.2 Current state of the industry

- **Soil, water, and air issues related to large livestock operations** - continue to dominate the agricultural industry. The primary stimulation is the construction of swine barns. The number of large swine and dairy operations are still on the increase . More and more municipalities are passing bylaws to try and control construction in an orderly fashion. Nutrient management plans, days of manure storage, and MDS II requirements are included in most bylaws. Interim control bylaws on large livestock building construction is common awaiting the proposed Agricultural Operations Act by the province. Variations occur when attempts are made to inventory land used for application of manure and guarantee application rates. Local resident organizations are still very vocal and well organized in presenting their concerns and demands. Municipalities are reacting accordingly.

- **Water Quality** - Much attention is still focussed on **bacteria and nitrates** as the primary contaminants in light of the Walkerton situation. Runoff from agricultural lands is being scrutinized from many fronts. Department of Fisheries and Oceans and Environment Canada are now getting involved more directly with situations that may be impacting fisheries in Ontario ie. two incidents in Eastern Ontario where charges have been laid. Demands to protect and create riparian zones along waterways and wetlands is also still on the rise.

  Phosphorous loading on streams is still a primary concern in many areas of the province. Many municipal treatment systems are dependent on rivers to assimilate treated waste water from cities and towns. Assimilative capacities of some rivers have reached or are reaching the maximum levels permitted . Municipalities are searching for cost effective alternatives such as "phosphorous trading" or "phosphorous credit" type accounting systems based on improvements to agricultural land and nutrient management techniques. Waterloo region has successfully implemented a financial incentive program in targeted areas to encourage implementation of BMP's in agricultural areas. Wellington County is nearing completion of its first year of a similar Rural Water Quality Program with the main difference that it is county based rather than a targeted watershed area. Other areas (Lake Simcoe, South Nations etc.) are in the process of also initiating similar programs. The problem still remains as to how to account for water quality improvements (phosphorous) which are hard to measure or take time to appear. Empirical and modelling methods are being developed for the purpose of accounting water quality gains.

- **The Environmental Farm Plan** process went through its seventh full year of operation and distributed close to 2000 workbooks which is consistent with previous years. This program is in jeopardy as it is in its final year of funding and new sources of monies have not been secured. The committee recognizes this program as valuable and important for its accomplishments. Some way should be found for its continuation. The incentive program which provides $1500 towards improvements identified in the Farm Plan is being well used and on the increase. The Rural Water Quality Program in Waterloo implemented a completed Environmental Farm Plan as a requirement of eligibility for the program as has the Wellington County program.

- **Activity in the tile drainage industry** - Activity in tile drainage installation is stable and similar to previous years.

  The Department of Fisheries and Oceans, in consultation with stakeholders, has developed a Class Authorization system for the maintenance and repair of existing municipal drains. They, in partnership with local Conservation Authorities, have funded the collection of data to catalogue the fish habitat that currently exists in municipal drains. This information is used to classify each municipal drain into six different categories. As a result, municipal drainage superintendents will be able to receive a "class authorization" for their proposed work, provided they follow the predefined conditions for that drain. This positive development promises to minimize the frequent conflicts between municipalities and environmental agencies in the maintenance and repair of existing municipal drains.

  The province has completed a review of their drainage programs. The results will be announced later in the year.

2.3.3 Emerging issues

- **Municipal Nutrient Management and Interim Control Bylaws to Control Development of Large Livestock Operations** - Large livestock operations are still on the rise in Ontario. Municipalities are reacting to the concerns of the public at large as well as reacting to bylaws instituted in neighbouring municipalities with the view that if neighbouring bylaws are more restrictive swine barn will move to those areas with less control. Municipalities have been given more responsibilities and power. Some are making full use of it. OFEC released a position paper on bylaw development which has helped to reduce the variability between municipalities but with limited success too date. Bylaws are replacing moratoriums on construction. Nutrient management plans are required in all the new bylaws along with MDS II and minimum storage requirements.

  Other variables that are being introduced are inventory of land used for manure spreading, verification of application rate, minimum acreage owned, registration of land to be used for manure application etc. Municipalities are searching for mechanisms to give them more control over the situation. Municipalities are hopeful that the new proposed legislation will address many of the enforcement concerns that cannot be addressed with existing mechanisms.

- **Community Resentment Towards the Establishment of Large Swine Operations -** Resentment towards the construction of large swine producing facilities continue to escalate. Guarantees of no odours, no ground water contamination, and no surface water contamination are being demanded. Rural residents who may not even be adjacent to or near the construction sites get actively involved. Some situations are even proceeding through the courts to challenge the construction and operation of larger swine barns. Recent incidents related to leakage from manure storages into tile drains have "fuelled the fires" even further.

- **An Accelerated Rise in Public Scrutiny, Interest and activity in Non-traditional Components of Water Pollution.** This is primarily focussed on pathogens but is likely to progress to nitrates in the future. Water quantity and quality issues are stimulating people to become more aware of other types of water pollution such as *Cryptosporidium*, giardia, residual medicines and hormones etc.. As their knowledge base increases so does their suspicions of what else might be out there that could be harmful and/or persistent. In many cases there is a link to agriculture. Nitrate has not been a focus of attention yet but is likely to be in the near future.

- **Application of Biosolids on Agricultural Land is Receiving Increased Scrutiny with Equal Attention as Livestock Manure. -** Biosolids application to farm land is being viewed with the same scrutiny as livestock manure. Public pressure is rising an likely to continue to increase for more monitoring and accountability. The existing Certificate of Approval is considered inadequate and insufficiently enforced.

- **Large Water System Regulations Require Well Head Studies** which are likely to lead to well head protection plans and likely to be restrictive to some agricultural activities. Small water systems are under review as well. Consultations are completed and results are being reviewed. Further regulations are being considered.

- **Municipal Waste Water Treatment Systems At Capacity and Looking at Less Costly Alternatives – Phosphorous Offset Methods. -** Housing is on the increase once again across much of the province and is putting increased demands on sewage treatment plants and the assimilative capabilities of receiving waters. Technology is not available or affordable to reduce phosphorous levels further necessitating a search for other methods to deal with the situation.

  Phosphorous is the key component. If Phosphorous levels in the river can be reduced ie. BMP practices by agriculture, present waste treatment technology can still be used (less costly). Another approach that is being looked at is look at the possibility of increasing river flow. Is there waste in the use of water or is too much water being used upstream (ie. irrigation)? These are both major issues for the farm community to face and the pressures will increase as more municipalities face waste treatment expansion and upgrades. Presently, there are four watersheds actively involved in this approach and many more will are forthcoming.

- **Drought Conditions Have Passed but Discussions on Water Rights and Allocation Will Continue. -** Water Response 2000 has been released and is being tested in two locations in the province. This plan outlines the roles and responsibilities of provincial and municipal governments, industry, Conservation Authorities, and the private sector when low water and drought conditions are experienced. Even the dry conditions have passed discussion on Water Rights and Allocation processes are likely to continue.

- **Greater Demand for Better Weather Forecasting and Networking for Better Management of Land Application of Manure and Biosolids as Well as for Surface Water Supply Management.** - Best management practices for manure application indicate that weather should be taken into account to avoid movement of manure into tile drainage systems and to avoid runoff. For this practice to be effective, better forecasting will be demanded. Managing surface water quantities for flood management as well as drought conditions are equally important and very dependent on accurate forecasting.

- **Drainage Looked at as Contributor to Low and High Flow Rates in Streams as Well as Water Quality Problems.** - In the past, drainage has been accused of increasing peak flows in channels. Now it is also being looked as a contributor to low flows in dry periods. Focus is on base flow reductions and reduced ground water recharge. In addition, tile drains are a pathway for contaminants especially manure from spreading practices. The use of tile drainage is being challenged.

- **Methane - Greenhouse Gas from manure. -** As more and more manure is spread on the land, methane is emitted into the atmosphere which threatens the ozone layer. As people look for more reasons why livestock agriculture should not expand, greenhouse effect could be the next front to deal with. Research is already started in Ottawa.

- **Vegetable Wash Water Quality and Legislation -** Concerns have been raised regarding fruit and vegetable wash water and how it is handled. Applying the legislation as it is in place could have serious economic impacts.

- **Livestock Access to Streams and Conflict with Fisheries Act -** The private sector is searching for new mechanisms to meet its expectations of stream water quality. Complaints have been lodged under the Fisheries Act, which is federal jurisdiction, and charges have been laid. This is an indication that the public is not satisfied with provincial response to complaints of this nature. Under the Fisheries Act it is much easier to verify a charge.

- **Irrigation Water Quality and Food Safety -** Irrigation water quality and food safety is an issue of the future. Limited situations have been encountered in Ontario ie. apple cider contamination. It is a rising issue in the US and is likely to be more important here in Ontario especially with fresh produce and quality of irrigation water that is used.

- **Nutrient Management Bylaw and Plan Court Challenge -** Even though nutrient management planning and bylaws are still in their infancy stages in terms of development, the public is not trusting and in their desire for greater environmental security have challenged the nutrient management approach in the courts. Interest is high from both sides of the issue and could greatly influence the future, depending on the ruling.

- **Impacts of weather on runoff and infiltration.** - 1999 was a dry year in approximately six locations in the province. Agriculture, urban water supplies, sewage treatment facilities, private water supplies, recreation, power generation, ecological systems were all affected. Reserves are very low. Problems and conflicts are probable for the coming year unless there is an unexpected turn around in the weather patterns. In some areas, it is projected that it will take 3 to 5 years of normal precipitation to get back to normal. Long term impacts have not yet been determined.

2.4 Crops Engineering

2.4.1 Major accomplishments since last report

- **Standby Power, Generators**
  - Canadian Standards Association establishing standards for Farm P.T.O. generators
  - Reference Booklet on Electrical Energy Disaster Planning Manual and Materials for electrical energy disaster plan in the event of extended power outages and energy shortages/delivery problems.
  - A Generic Safe Operating Procedures Manual (SOP) includes instructions on maintenance as well as operations.
  - A summary sheet Checklist that can be attached to the stand-by power system.
  - Slide-set for producers on energy efficiency
  - On Farm Standby & Auxiliary Power Systems Hand book
  - Video : Emergency Generators – Safe Use on the Farm
  - Information CD of On Farm Standby Power
  - Compower Generator computer sizing software

- **Equipment Safety Features and Lighting**
  - Canadian Standards Association Technical Committee establishing standards for extremity lighting and equipment visibility
  - M669-97 (ANSI/ASAE S279.9 Jul93) Lighting and Marketing of Agricultural Field Equipment on Highways
  - M673-99 (ANSI/ASAE S338.4 Nov97) Equipment for Agriculture – Safety Chain for Towed Equipment
  - Farm Vechicles & Equipment and the Highway Traffic Act. MTO Nov. 2000.
  - M671 – 99 (ASAE S276.5 Nov97) Slow – Moving Vehicle Identification Emblem
  - M675-99 (ASAE S365.3 Jul97) Braking System Test Procedures and Braking Performance Criteria for Agricultural Field Equipment

2.4.2 Current state of the industry

- **Conflict with neighbours -** Ontario's agriculture and food industry contributes $25 billion to the provincial economy every year, and employs some 640,000 people. It is Ontario's second largest industry. To remain competitive, farmers must expand and adopt new, more efficient production methods. Some times expanding or new farm operations encounter serious conflict with neighbours.

- **Nutrient Management Plan -** Farm, rural, environmental and urban groups are studying the issues that put farmers in conflict with their neighbours. In Ontario food production and rural housing in the most part are neighbours. Good neighbours need to trust each other, one way to build trust is by having the agricultural operations do a Nutrient Management Plan.

- Currently there is a consultation of the rural community with respect to what can be done to ensure that Ontario has adequate **food supply, food safety, environmentally sound farm practices and minimum conflicts**.

2.4.3 Emerging issues

- **Mad Cow Disease and Food Safety -** The BSE crisis in Europe has resulted in a 25 % drop in meat prices, which, along with the generalized depression of market volumes, worries exporters. Many scientists believe that humans who catch new variant Creutzfeldt-Jakob Disease (vCJD), the human equivalent of BSE, do so as a result of eating BSE-infected beef. More than 80 people in Britain and two in France have so far died of vCJD. All tests in Austria have so far been negative, as they have been in Sweden and Finland. ***DUBAI, Jan 18 (Reuters)* -** Saudi Arabia's beef importers are turning to Australia after the kingdom banned beef and mutton imports from the European Union due to fears of mad cow disease. Saudi Arabia may also turn to New Zealand, South and North America or South Africa to meet its needs.

- **New Markets for all Natural Beef** - For example Argentina tells the world about its pasture-fed cows. The Argentine government began a worldwide campaign in Germany in order to promote the healthiness and quality of Argentine meat products. "Argentine cows are old fashioned, they only feed on pasture". Argentine cows are only fed with natural pasture, with no supplementation based on animal flours

- **ISO 9001 certification of Agricultural Operations -** Last November, Los Grobo Agropecuaria became the first farming operation in Argentina to receive ISO 9001 certification for its processes of production and commercialization of agricultural inputs. The globalization of agricultural markets and of the economy in general demand that the excellence of a company and the recognition of its quality and competitiveness can no longer be based solely on tradition and brand recognition. Today it is necessary to certify that the characteristics of a product or a process are optimal in order to aspire to gain new markets.

- **Foods made from Genetically Modified Organisms (GMO)** - Segregate Harvest and Storage of GMO Foods? The controversy swirling around biotech-based crops is creating a great deal of uncertainty about seed purchasing decisions. And it could lead to some fundamental changes in the way you market your crops. Protests about GMO crops will mostly not die down. In real life perception is reality and farmers can grow GMO crops however having a market is some thing else. Farmers are being asked to be market wise when deciding what to grow.

  Farmers who decide to grow some GMO crops must be ready to segregate harvest and storage of these crops. This will also mean that companies down the food delivery line like processors will have to segregate also.

  The StarLink scare may curb Asian appetite for US corn TOKYO, Oct 26 (Reuters) - Controversy over a banned biotech corn called StarLink is casting a cloud over the outlook for U.S. grain exports to East Asia, which accounts for some 50 percent of the U.S. corn export market.

  The market effect of the loss of European markets for GMO's may be hard to measure and may be hyped in the media, since most U.S. corn and soybeans still feed domestic livestock. But if the U.S. consumer market gets riled up over GMO's in McDonald's hamburgers and other foods, we've got a problem in the U.S. and in Canada. These are pretty big risks, especially if the economic benefits from GMO's are marginal.

3.0 REPORT OF ACTION TAKEN SINCE LAST ANNUAL REPORT

Food Research Program 2000-2004

This year the Food Research Program was reviewed and a long term Program has been developed to effectively use resources within the University of Guelph, including clusters funded recently by the Canadian Foundation for Innovation and Ontario Innovation Trust, as well as collaborating organizations (e.g. Agriculture and Agri-Food Canada, Health Canada, Canadian Food Inspection Agency, Guelph Food Technology Centre) to address research priorities of the Ontario Agricultural Services Coordinating Committee (OASCC). Research needs identified through the Food Industry Competitiveness Branch of OMAFRA (as reported in the OFPRSC 1999 Strategic Report for 2000 - 2004) and the Canada Committee on Food, a committee of the Canadian Agri-Food Research Council (CARC) have also been considered.

The following objectives and goals were set for this period (2000-2004)

Objective 1: Ensure safety and improve quality of Ontario food products.

Objective 2: Develop value-added components in Ontario-grown food products.

Objective 3: Design innovative technologies to manufacture traditional and new food products.

Goal 3.1 Develop appropriate technologies to extract and stabilize value-added components from Ontario agricultural resources as well as manufacturing waste streams.

Goal 3.2 Improve existing and develop new technologies for food preservation.

4.0 ISSUES

The Livestock Engineering, Rural Environment Engineering, and Crops Engineering Subcommittees included Issues in the Emerging Issues parts of Section 2 of this report. The summary of these issues and recommended action is reflected in the list of recommendations found in Section 5.

4.1 Food Engineering

- **Advanced and novel food processes for better productivity, quality and safety of food** - One of the processes identified is the non-thermal pasteurization of liquid foods using pulsed electrical field. The work is being conducted for the last few years at the School of Engineering, University of Guelph. Several hurdles have been removed. However more work is needed to make this process commercially viable.

Three processes identified are deep-fat frying, pan-frying and baking. Some work on deep-fat frying is in progress at the School of Engineering. Work is needed in the areas of pan-frying of meat patties for *E.coli* safety, and on baking for better product quality.

High pressure processing (HPP) is becoming an important commercial cold food preservation technology in Europe, USA, and Japan. However, its application is limited in Canada and there is not any commercial or experimental unit in Ontario. This process not only inactivates the microbes but also maintains the quality thus it is good for neutraceuticals and foods fortified with neutraceuticals. The subcommittee recommends this is an urgent need. Collaboration between federal and provincial governments in this area is urged.

Ozone application to fruits and vegetables (reducing waste and chlorine use) and its potential application to grains (to replace CO_2 and Fumigants) to prevent bacteria, fungus and mould is an other area to be investigated. A large quantity of fruit and vegetables is produced in Ontario during the summer. However, these produces can not be economically stored for long time and finding new ways to preserve them at reasonable cost would increase the income to farmers and reduce the cost to consumers. This also cut down on chlorine use and disposal.

The price and the demand for beans grown in Ontario are very low and there is a need for increasing the price and the demand. There are research needs in new product and process developments such as ready to eat meals, easy digestible products, easy cooking products, and uniform dehydration process.

- **Sensors, image processing and automation for higher productivity, safety and quality** - In-line sensors for the detection of contaminants and quality parameters in foods are needed for consumer safety and product quality. Three processes were identified for image processing: inexpensive in-line methods for detection of glass pieces in glass containers, small chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans. No work is in progress on these areas.

  Three in-line sensors were identified: for microbial detection, moisture at high temperature for baked foods and dough properties. Some work is in progress on microbial sensor in the University of Guelph, but no work is being carried out on other sensors.

- **Neutraceutical processing -- separation, purification and concentration** - Work is needed on the development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.) to be used in supplements and in fortified foods. Some work is in progress in the University of Guelph, and AAFC laboratory in Guelph. However more work is needed. This need was also identified by CARC.

- **Characterization of raw ingredients for quality control in processed foods** - No work is in progress in Ontario on this or related topic. There is a need for low cost and high quality locally produced ingredients for small and medium sized companies. Evaluation of raw materials and ingredients for their physical and functional properties are important.

- **Wine and beer industry growth in Ontario requires optimum material handling -** Applied research is needed in this area for expanding Ontario wine industry. No work is in progress at present.

- **By products utilization and environmental (waste and air quality) quality** - Applied research is needed to develop value added food and non-food product from food waste and reducing air and water pollution.

5.0 RECOMMENDATIONS ARISING FROM THE IDENTIFIED ISSUES

A complete list of recommendations follows, grouped by engineering subcommittee. New recommendations and those that have been re-focussed are listed in detail in Section 5.5. Details for all other recommendations are found in the appended subcommittee reports.

5.1 Food Engineering

18. Improved technologies for pasteurization, such as non-thermal processes, to reduce processing cost and to enhance nutritional and flavour quality, and shelf life. [Previous recommendation]

19. Baking and frying processes modelling to improve baked and fried products' quality. [Previous recommendation]

20. Image processing for inexpensive in-line methods for detection of glass pieces in glass containers, chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans. [Previous recommendation]

21. Development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.) to be used in supplements and in fortified foods. [Previous recommendation]

22. In-line sensors for microbial detection, moisture at high temperature for baked foods and dough properties. [Previous recommendation]

23. Raw material characterization for food product quality. [Previous recommendation]

24. Optimizing material handling in wine and beer industry. [Previous recommendation]

25. By product utilization and waste management. **[New]**

26. Process development for new products for small processors. **[New Service Recommendation]**

5.2 Livestock Engineering

4. Development of standards for the construction of manure storage structures and manure handling systems. **[New]**

5. Measurement and improvement of air quality in livestock buildings: [Previous recommendation]

6. Measurement and prevention of corrosion and deterioration of agricultural building components: [Previous recommendation]

5.3 Rural Environment Engineering

27. To develop improved systems for applying manure to no-till, hay, and pasture land more accurately, cost effectively, with fewer odours and low risk of movement to tile drains. [Previous recommendation - modified]

28. To evaluate and quantify the impact of large livestock operations on the rural environment. [Previous recommendation - modified]

29. To investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land.**[New Focus]**

30. To identify sources of microbiological and pathogen related water contamination in agricultural watersheds and put into perspective the various contributors. [Previous recommendation]

5.4 Crops Engineering

1. Development of non-compacting field equipment **[New]**

2. Development of new grain and forage processing (drying) systems [Previous recommendation]

3. Development of applicators to apply manure and bio-solids uniformly on the land at desired rates and odour control [Previous recommendation]

4. Rural roads and transporting equipment safety - **[New Service Recommendation]**

5.5 Detailed Recommendations

ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

Food Engineering - Recommendation #8

Issue: Waste management and air and water pollution control.

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC, FCC and OMAFRA.

Title: By-products utilization, waste management and air and water pollution control.

Details:
Economical disposal of wastes is becoming a problem as the land and waterways are limited around the processing plants and strict regulation is being imposed. Presently byproducts from many food industries are going for animal feeding. Research is needed to utilise the byproducts from corn, apple, and grape processing industry. Other sources of waste are cheese whey, soy processing waste, liquid egg processing waste, food packaging materials are some of the major sources. Processing waste can be minimised by reducing the byproducts generation and utilising them to produce value added food and non-food products.

Water quality and air quality for food processing is also becoming more critical. Effective use of water and reuse of wastewater are needed. Removal of Odour and particles from the air coming from food processing plant is becoming very important.

Background:
Producing value added food and non-food products from the under utilised or waste material and finding economical ways to reduce water and air pollution generated by the food industry would be an advantage to the industry therefore, more research in this area is required

This recommendation should be addressed by the industry, research institutions and academic researchers. It is difficult to estimate the economical impact on this.

ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

Food Engineering - Recommendation #9

Issue:	Process development, product safety, good manufacturing practices for small processors
OASCC linkage:	Food processing committee.
Target agencies:	Recommendation to ARIO, AAFC, FCC and OMAFRA.
Title:	Process development for new products for small processors

Details:
Due to the rapid expansion of small food processors who has very little capital to invest in short term R&D and long term high risk research, there is a need for conducting research at public research institutions. These research institution should focus on process and product development suited for small processors and to produce small scale speciality products to increase the profit. Lack of research support would make the long term survival of these processors questionable.

Background:
The statistics shows that small companies are hiring more people and the long term survival of small food processors would be an added benefit to the economy of the province.

This recommendation should be addressed by the industry, research institutions and academic researchers.

ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

Livestock Engineering - Recommendation #1

Issue:	Manure impacts on water quality
OASCC linkage:	Animal Committee
Target agencies:	Agricultural Research Institute Of Ontario, Canadian Agricultural Research Council, Ontario Ministry of Agriculture, Food & Rural Affairs
Title:	Development of Standards for the Construction of Manure Storage Structures and Manure Handling Systems

Details:

Techniques used in the construction of manure storage structures, transfer piping, etc. have been found in some situations to be lacking quality of workmanship. The proposed new Agricultural Operations Act will require that appropriate standards be developed to ensure that construction quality is high. Research is needed:

1. To assess current construction techniques and to verify the integrity of the manure storage system in a full scale building test.
2. To develop standards for steel, concrete, earthen storages, synthetic and clay liners, transfer piping, etc.
3. To develop protocols that will ensure a uniform and appropriate level of building inspection.
4. To recommend changes to the National Farm Building Code - to ensure that all components of the manure storage and handling system are regulated.

Background:

Issues related to integrity of manure storage and transfer plumbing have been encountered in the past several years. There are concerns that construction techniques used on a significant number of projects are allowing manure to escape into local groundwater reserves or nearby field drains. We need to know if shrinkage cracking in concrete floors and walls will allow the passage of manure in significant quantity. As well, construction joints need to be evaluated for their ability to protect against manure leakage. A full-scale project, utilizing a newly constructed livestock facility would provide much needed data to assist us in determining the integrity of current construction methods.

Cost/Benefit:

It is estimated that the research needed to address these concerns would potentially cost approximately $100,000. Ministry of the Environment has estimated that the cost of cleaning up liquids that spill into the environment is approximately $40-50 per gallon. This means that if

2000-2500 gallons of manure leakage could be reduced by this project, the cost would be reclaimed. It is estimated that the leakage from livestock operations in Ontario exceeds this amount significantly. Payback from this project could be very significant. Remedial measures for existing operations would have the largest impact on the environment. Since it is difficult to put a price on clean water, it is safe to say that research dollars spent on this item would be well placed.

Resources: Ontario Pork has already conducted some research in this area and have committed to provide funding to carrying out further research. OMAFRA and Ridgetown College have also made a commitment to participate in research in this subject area. OMAFRA has been involved in the preparation of standards for components of manure storage and handling systems. It is anticipated that this involvement will continue.

ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

Rural Environment Engineering - Recommendation #3

Issue: Manure treatment to reduce adverse impacts on soil, air and water quality

OASCC linkage:

Target Agencies: AAFC, ARIO, CC - Animals

Title: Investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land.

Details:
This project involves an examination of various manure treatment options with the specific goal of reducing odour levels at the barn and storage. It is especially aimed at liquid swine manure systems, though the suitability for other livestock types should also be considered. Treatment could occur during collection, during transfer to storage, during storage, or some combination. The feasibility of biofilters, mechanical systems, aeration, bacterial and enzyme methods etc. need to be investigated. There are two phases of odour generation to investigate i) from the barn and ii) from the storage. Some of these technologies have been successfully applied to urban and industrial applications. There needs to be a concerted effort to apply these technologies to treatment of livestock manure.

Background:
Livestock manure, like any other biological material, undergoes a breakdown of organic matter by microorganisms. When this happens in anaerobic conditions, such as with traditional liquid manure systems, it results in odours. Proper separation distances to conflicting land uses, good housekeeping practices, and covers on storages are examples of methods farmers have used to reduce odour impacts. These approaches are not enough to satisfy the present day rural population. Manure treatment research has been going on for many years but the focus has not always been odour control - other factors have included: reducing volume, concentrating or changing the form of nutrients, producing methane, etc.

Research is needed to examine methods of odour control practical for use on today's farms, especially targeted at large swine farms with liquid manure.

Composting of liquid manure is one technology that is being investigated and should continue. Others include biological treatment, chemical treatment, methane digestion, use of additives, mechanical aeration, separation in combination with a further treatment step, and dehydration.

Cost/benefit:
This research will be of greatest benefit to large operations using liquid manure, especially swine. The viability of the industry hinges on being able to expand and build these specialized units. Better solutions are required than bylaw control which will greatly hinder the competitiveness of the industry.

Resources:
This project needs the cooperation of researchers in waste management, odour control, and economics, as well as livestock specialists, agricultural systems specialists, and livestock farmers. Lab and Farm-scale projects will be needed.

ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

Crops Engineering - Recommendation #1

Issue:	Compaction, soil quality
OASCC linkage:	
Target Agencies:	AAFC, ARIO, CC - Natural Resources & Crops, OMAFRA, CARC
Title:	Development of non-compacting field equipment

Details:
Work is needed to reduce soil pressure caused by farm equipment. Currently tire soil pressures can be quite high for large liquid manure spreaders (48 psi) , Combines, rear 10 - 32 psi & front 22 to 37 psi. and grain buggies (48 psi). Research is needed to design new equipment or modify existing designs to reduce soil pressures for, manure spreaders, combines, grain buggies, fertiliser spreaders etc.

As farm operation have grown, farm equipment, combines and tractors have become larger and heavier. Manure spreaders can weigh as much as 14 tons and tractors 20 tons. Soil compaction stunts plant growth causing yield decreases. There has been lots of work done on reducing tractor pressure loads by using dual, radial tires and four-wheel drive. Current management of large tractors can in most cases reduce pressure loads to 6 to10 psi on the ground.

Background:
In 1992, agricultural tire industry changed their load-inflation pressure tables for radial ply tires toward lower inflation pressures. The new tables extend down to inflation pressures of 6 psi for light loads, instead of the previous lower limit of 18 psi. This came about in an effort to reduce or eliminate 'power hop' of large four-wheel drive tractors. Lower tire inflation pressure increases the footprint of the tire, increases the tractive efficiency and capability of the tire, and decreases soil compaction. It is important that the tire pressure not be too low for the load on the tire. A recent Ohio State University study using four-wheel-drive tractors showed a reduction in compaction when tires were inflated at 6-7 psi rather than at 24 psi. Also, equipment with 2- or 3-foot-wide rubber tracks were almost as effective in cutting down compaction as tractors with the low-pressure tires. Work is needed to reduce soil pressure caused by farm equipment.

Cost Benefit:
“Soil compaction is like a silent burglar who steals yields when you've dozed off”, says Ohio State agricultural engineer Randall Reeder. Data for 2000 shows that corn yields on compacted plots were 11 bushels per acre lower than in control plots, and that soybean yields on compacted

plots were 5.5 bushels per acre lower than in control plots. The yield differences were 7 percent and 12 percent lower than control plots for corn and beans, respectively.

ONTARIO AGRICULTURE AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE

Crops Engineering - Recommendation #2 - Service

Issue: Road safety

OASCC linkage:

Target Agencies:

Title: Rural roads & transporting equipment safety

Details:

Rural road farm and non- farm traffic is increasing. Farm equipment has increased in size, as a respond to the economic pressures to make farming more cost efficient. Farms are larger than in the past, so operators are forced to travel greater distances on the roadways between fields. Cars and trucks are sharing the road with combines and tractors pulling equipment that fill a good portion of the road. Accidents are occurring with these large equipment and cars and trucks. There are a number of safety issues that need to be addressed urgently by the public and private sector.

Effort is needed to:

1. Develop an education and information program to increase visibility of agricultural equipment on public roads in dark or poor lighting conditions.
2. Develop an awareness program on the moving of large farm equipment for non farmers and farmers
3. Develop standards for the use of lights or reflective tape (similar to type on transport trucks) on farm machinery on public roads for front and rear viewing of other road traffic in low and no-light conditions.

Background:

There were over 2,500 farm-related highway accidents in which 842 persons were injured and 33 killed in the last five years according to the Ohio Department of Highway Safety. In Ontario accidents involving tractors in 1992 were 165 accidents 2 deaths, 39 personal injuries and 124-property damage. There are no stats on just farm equipment accidents. Lack of visibility is a major cause of many accidents.

6.0 SUMMARY OF DISTRIBUTION OF RECOMMENDATIONS

Engineering recommendations to:

AAFA	Agriculture & Agri-food Canada	
ARIO	Agricultural Research Institute of Ontario	
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs	
CC	Canada Committees	1 = Natural Resources
		2 = Crops
		3 = Animals
		4 = Food
CARC	Canadian Agricultural Research Council	
MOE	Ontario Ministry of the Environment	
FS	Farm Safety Association	

6.1 Food Engineering

	To Agencies					
Recommendation	AAFC	ARIO	CC	CARC	OMAFRA	Other
1. Improved technologies for pasteurization such as non-thermal processes to reduce processing cost and to enhance nutritional and flavour quality, and shelf life		X			X	
2. Baking and frying processes modelling to improve baked and fried products' quality	X	X			X	
3. Image processing for inexpensive in-line methods for detection of glass pieces in glass containers, chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans	X	X			X	

4. Development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.)	X	X			X	
5. In-line sensors for microbial detection, moisture at high temperature for baked foods and dough properties	X	X	4		X	
6. Raw material characterization for food product quality	X	X	4		X	
7. Optimizing material handling in wine and beer industry	X	X	4		X	
8. By-products utilization, waste management and air and water pollution control.	X	X	4		X	
9. Process development for new products for small processors	X	X	4		X	

6.2 Livestock Engineering

To Agencies

Recommendation	AAFC	ARIO	CC	CARC	OMAFRA	Other
1. Development of Standards for the Construction of Manure Storage Structures and Manure Handling Systems		X	X	X	X	
2. Air quality in livestock buildings	X	X	X	X		
3. Corrosion And Deterioration Of Agricultural Building Components	X	X	X	X		

6.3 Rural Environment Engineering

To Agencies

RECOMMENDATION	AAFC	ARIO	CC	CARC	OMAFRA	Other
1. To develop improved systems for applying manure to the no-till, hay, and pasture land more accurately, cost effectively, with fewer odours and low risk of movement to tile drains.	X	X	1			
2. To evaluate and quantify the impact of large livestock operations on the rural environment.	X	X	3			MOE
3. Investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land.	X	X	3			
4. To identify sources of microbiological and pathogen related water contamination in agricultural watersheds and put into perspective the various contributors.	X	X	1			MOE

6.4 Crops Engineering

To Agencies

Recommendation	AAFC	ARIO	CC	CARC	OMAFRA	Other
1. Develop non-compacting field equipment	X	X	12	X	X	FS
2. Develop applicators for solid & liquid manure plus Bio-solids to Apply Manure & Bio-Solids Uniformly on the Land and control odour.	X	X	12	X	X	
3. Grain and Forage Processing (Drying)	X	X	12	X	X	

APPENDICES

Appendix I : **Subcommittee Reports**

- **Food Engineering Research & Services Subcommittee**
- **Livestock Engineering Research & Services Subcommittee**
- **Rural Environment Engineering Research & Services Subcommittee**
- **Crops Engineering Research & Services Subcommittee**

Appendix II : **Committee and Subcommittee Membership**

Appendix I : Subcommittee Reports

Food Engineering Research & Services Subcommittee

☐ **Livestock Engineering Research & Services Subcommittee**

☐ **Rural Environment Engineering Research & Services Subcommittee**

☐ **Crops Engineering Research & Services Subcommittee**

FOOD ENGINEERING SUBCOMMITTEE

REPORT TO
ONTARIO AGRICULTURAL AND FOOD
ENGINEERING RESEARCH AND SERVICES
COMMITTEE

November, 2000

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LIST OF ACRONYMS

AAFC	Agriculture and Agri-Food Canada
ARIO	Agriculture Research Institute of Ontario
CARC	Canadian Agricultural Research Council
CCC	Canada Committee on Crops
CCF	Canada Committee on Food
FRDC	Food Research and Development Centre
GDP	Gross Domestic Product
GFTC	Guelph Food Technology Centre
HACCP	Hazard Analysis and Critical Control Points
MISA	Municipal-Industrial Strategy for Abatement
MMO	Materials and Manufacturing Ontario
NRC	National Research Council Canada
OAFERSC	Ontario Agriculture and Food Engineering Research and Services Committee
OASCC	Ontario Agricultural Services Coordinating Committee
OFPRF	Ontario Food Processing Research Fund
OFRSC	Ontario Food Processing Research and Services Committee
OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
SOE	School of Engineering
TQM	Total Quality Management
UOG	University of Guelph

1.0 EXECUTIVE SUMMARY

The Food Engineering Subcommittee presents this report to the Ontario Agriculture and Food Engineering Research and Services Committee (OAFERSC). The need to be competitive in the World marketplace remains the number one challenge facing the food manufacturing sector in Ontario. In reviewing the actions that would benefit Ontario food processors, the Food Engineering Subcommittee has decided to place the highest priority on the following recommendations.

RESEARCH PRIORITIES

1. Improved technologies for pasteurization such as non-thermal processes to reduce processing cost and to enhance nutritional and flavour quality, and shelf life.

2. Baking and frying processes modelling to improve baked and fried products' quality.

3. Image processing for inexpensive in-line methods for detection of glass pieces in glass containers, chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans.

4. Development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.) to be used in supplements and in fortified foods.

5. In-line sensors for microbial detection, moisture at high temperature for baked foods and dough properties.

6. Raw material characterization for food product quality.

7. Optimizing material handling in wine and beer industry.

8. By product utilization and waste management

2.0 INTRODUCTION

This is 2000 report of the Food Engineering Subcommittee to OAFERSC. Food engineering is a specialized discipline within the engineering profession and food engineering research and service are necessary supports to the Ontario food processing industry. In addition to reviewing these areas within the Food Engineering Subcommittee, food engineers serve on other committees and subcommittees within the OASCC committee structure. The Food Engineering Subcommittee recognises the importance of maintaining closer interactions with the Ontario Food Research and Services Committee (OFRSC) as well as the Expert committees on Food Engineering and Refrigeration at the national level.

The Food Engineering Subcommittee has representatives from producers' boards, private sector, OMAFRA, University of Guelph, Agri. & Agri.-Food Canada and the National Research Council (NRC).

3.0 MISSION or MANDATE

Concerns itself with the research and services regarding technology, processes and equipment related to the production side of the food processing. This is in contrast to the Food Science concerns which are food product related. There is of course, a great deal of interdependent, interaction between these engineering and science disciplines.

4.0 INDUSTRY/SECTOR SCAN

4.1 Major accomplishments since last report

(a) Mr. Hugh W. Fraser (OMAFRA) continued his work on a CanAdapt project "Controlled ripening and reduced ethylene effects in horticultural crops using novel ethylene antagonists". Highlights are: (i) Ethylene speeds up senescence of many horticultural crops with a resulting decrease in shelf life. (ii) Ethylene improves quality of bananas and tomatoes by promoting faster more uniform ripening before distribution. (iii) Ethylene is produced whenever organic materials are stressed, oxidized, or combusted. (iv) Ethylene causes premature yellowing of produce such as spinach, broccoli, parsley, cucumbers, and causes damage to most floral commodities. To date, the horticultural industry has already made changes based on his findings. Subtle changes in management could save the industry millions of dollar annually.

(b) Mr. Hugh W. Fraser (OMAFRA) spent 20% of his time on extension work dealing with the post-harvest handling of horticultural crops. This includes; forced-air cooling demonstrations and advice to growers; advice on reusable plastic shipping containers; cold storage troubleshooting, etc.

(c) Vibration response of Mozzarella cheese at various fat and moisture contents for process monitoring and control – Dr. G.S. Mittal and Dr. J. Zhang: The objective of this study was to analysis the relationships between vibration response of Mozzarella cheese of different fat and moisture contents and to find the feasibility of analyzing cheese composition for process monitoring and control. Mozzarella cheese samples with different fat and moisture contents were vibrated vertically on a vibration exciter through a range of frequencies from 10 to 1000 Hz. The frequency response was modelled by a single-degree-of-freedom Kelvin model. There were 3 resonance frequencies when cheese samples were vibrated. The first was around 200 Hz, second in 350-400 Hz range and third near 700 Hz. Natural frequency (ω_n), critical damping (C_c) and stiffness (K) increased linearly with fat content increase. ω_n, C_c and K reduced nonlinearly with moisture content increase. Models describing changes in these parameters with chemical composition could be used to monitor cheese composition using a sensor based on this concept.

(d) Method and apparatus for electrically treating foodstuffs for preservation – G. S. Mittal, S.Y. Ho, J.D. Cross and M.W. Griffiths: A US patent was assigned on this on July 25, 2000. A method and apparatus for electrically treating foodstuffs flowing through a treatment chamber with low energy, high voltage electrical pulses for non-thermal pasteurization and/or sterilization.

Instant-charge-reversal electrical pulses are applied to a foodstuff located between two electrodes in a treatment chamber, each electrical pulse having a pulse width in a range from about 1 to 5 μs with vertically rising voltage to a peak followed immediately with a decreasing voltage through zero volt and continuing to a voltage peak of opposite polarity and rising vertically back to zero volt. The vertical pulses are very low energy (0.1 to 25 J/pulse) and the field strengths are in the range 15 kV/cm to 120 kV/cm. The apparatus uses an electrode arrangement including a cylindrical inner electrode and inner disc with the cylindrical electrode inserted through the hole in the disc. 25 claims were approved on this technology under this patent.

(e) Pasteurization of raw skim milk by pulsed electric fields and antimicrobials – K. Smith, G. S. Mittal and M.W. Griffiths: This was an investigation of the microbial inactivation in raw skim milk by pulsed electric field treatment and antimicrobials nisin and lysozyme. The innovative technology of using a high-voltage pulsed electric field (PEF) for pasteurizing milk offers advantages of low processing temperatures and low energy utilization, while inactivating pathogenic microorganisms especially when combined with other preservation methods. A 7.0 log reduction of microorganisms found in raw skim milk has been achieved through a combination of pulsed electric field treatment (80 kV/cm, 50 pulses), mild heat (52°C) and addition of the natural antimicrobial peptides nisin (3000 IU/ml) and lysozyme (1000 μg/ml). The combination of PEF, mild heat and antimicrobials resulted in a much higher microbial inactivation than the sum of the individual reductions achieved from each treatment alone, indicating synergy. Varying the pH from 6.7 to 5.0 had no effect on microbial inactivation.

(f) Comparative evaluation of edible coatings to reduce the fat uptake in deep-fat fried foods – S. Albert, G.S. Mittal: Eleven different hydrocolloid materials including gelatine, gellan gum, a κ-carrageenan-konjac-blend, locust bean gum, methyl cellulose, microcrystalline cellulose, pectin, sodium caseinate, soy protein isolate, vital wheat gluten and whey protein isolate were chosen for investigation and compared for their film forming ability, their suitability for frying experiments and their water and fat transfer properties. Soy protein isolate, whey protein and methyl cellulose gave the best results and are very promising as coating materials for low fat fried food. The composite coatings provided >90% fat reduction were: soy-protein isolate + whey protein (99.8% ± 9.0% fat reduction), whey protein + sodium caseinate (95.6% ± 4.6%), whey protein + microcrystalline cellulose (93.6% ± 5.9%) and soy-protein isolate + whey protein (91.4% ± 6.6%). More work is needed to improve the water transfer properties of these films. Thus to reduce fat uptake in fried foods, a novel concept of composite coating was developed.

(g) Dr. V. Davidson's (SOE) research is related with computer-based process control and decision-support in food processing. Research supported by the OMAFRA Foods program ("Software and Sensors for improved control of food processing") extended the fuzzy inferencing techniques to automated inspection of food products. Funding for this research was also obtained from Materials and Manufacturing Ontario (MMO), and supported by Dipix Technologies Inc. (Ottawa-based manufacturer of Qualivision™ systems) and Nabisco Brands Inc. (Peek Frean Bakery, East York).

Publications and Presentations

Publications

(a) Peer-reviewed journal publications

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Ju, J. and G.S. Mittal. 2000. Relationships of physical properties of fat-substitutes, cooking methods and fat levels with quality of ground beef patties. J. Food Processing and Preservation 24:125-142.

Bangu, N.T.A., S.T.A.R. Kajuna and G.S. Mittal. 2000. Storage and loss moduli for various porridges. Int. J. Food Properties 3(2):275-282.

Beal, P. and G.S. Mittal. 2000. Vibration and compression responses of Cheddar cheese at different fat content and age. Milchwissenschaft (Milk Sci. Int.) 55(3):139-142.

*Rayner, M., V. Ciolfi, B. Maves, P. Stedman and G.S. Mittal. 2000. Development and application of soy-protein films to reduce fat intake in deep-fried foods. J. Sci. Food Agric. 80:1-6.

Mittal, G.S. and J. Zhang. 2000. Vibration response of Mozzarella cheese at various fat and moisture contents for process monitoring and control. Milchwissenschaft (Milk Sci. Int.) 55(2):79-82.

Mittal, G.S. and J. Zhang. 2000. Prediction of temperature and moisture content of frankfurters during thermal processing using neural network. Meat Sci. 55(1):13-24.

Mittal, G.S. and J. Zhang. 2000. Flow behavior parameters of wheat flours using triaxial cell. Int. J. Food Properties 3(3):473-483.

Correia, L.R. and G.S. Mittal. 2000. Functional properties of some meat emulsion extenders. Int. J. Food Properties 3(3):353-361.

(b) Books, chapters in books and reports

None

(c) Theses

Smith, K. H. 2000. Pasteurization of raw skim milk by pulsed electrical fields and antimicrobials. M.Sc. thesis, University of Guelph.

Lu, Q. 2000. Predictive modelling of inactivation of alkaline phosphatase under high-temperature short-time pasteurization. M.Sc. research project, University of Guelph.

Iu, Janet. 2000. Evaluating survival of Escherichia coli O157:H7 in apple cider by electric fields. M.Sc. research project, University of Guelph.

(d) Conference proceedings or abstracts

Mittal, G.S. and J. Zhang. 2000. Prediction of H^+ concentration in frankfurters using neural network during cooking. Proc. 46th Int. Congress of Meat Sci. and Technology, Buenos Aires, Argentina, p254-255.

Ho, S, G.S. Mittal and M.W. Griffiths. 2000. Non-thermal pasteurization of fruit juices using low energy pulsed electrical field. 8th Int. Conf. on Engg. & Food, Pueblo, Mexico, Book of Abstracts, p102.

*Mittal, G.S. and J. Zhang. 2000. Artificial neural network for heat and mass transfer predictions in foods coated with edible films during frying. 8th Int. Conf. on Engg. & Food, Pueblo, Mexico, Book of Abstracts, p 41.

Hugh, F. 1999. , 'Monitoring Chronic Ethylene Gas Levels Throughout the Horticultural Industry' was presented at 1999 ASAE/CSAE Annual International Meeting in Toronto in July 1999. ASAE Paper # 99-1077

(e) Popular press articles

Mittal, G.S. 2000. Shocking news about juice. Research 15(1):13, by Marianne Clarke.

*Mittal, G.S. 2000. Reduced-fat french fries coming soon. Guelph Mercury, Sept. 9, 2000, p.B7, by Michelle Osborne.

*Mittal, G.S. 2000. Coming soon: Guilt-free fries. @Guelph, Sept. 27, 2000, p.11, by Michelle Osborne.

(f) Patent

Mittal, G.S., S. Y. Ho, J.D. Cross and M.W. Griffiths. 2000. Method and apparatus for electrically treating foodstuffs for preservation, US 6,093,432, July 25, 2000.

4.2 Current state of the industry

Down-sizing and consolidation of Canadian and U.S. operations continue to impact the structure of many Ontario food processing companies. Due to regional and global trade agreements, the food industry in Ontario is facing **international competition**. This will require considerable readjustment, productivity improvement and enhancement in product quality and safety. There is a large emphasis on value-added aspect of food processing. Downsizing putting less emphasis on R & D and more on organization aspects. Resources in Engineering R & D are decreasing due to overhead cuts and profit oriented approach. Food engineers are leaving to other industries and consulting due to less job satisfaction.

Less competition is being created due to merging as the number of owners are decreasing in each food sector. On the other hand, **Co-packing** is increasing where smaller food processors are processing foods for larger processors. For this reason and in general, small food processing companies are increasing in numbers. Employees at these companies are paid lower wages. Many small companies are producing specialized food products. Ethnic group food companies are also emerging to supply special food items to various communities.

However, these smaller processors are facing the followings: 1. Need of R&D on process and product development, 2. Need of whole infrastructure, 3. Compliance of processing facility sanitary, product safety, and labelling requirements as per USDA/FDA regulation for export, 4. Expansion of process lines to increase the output, 5. Developing process lines for multiple use or multiple products, and 6. Producing more and more value added foods. These factors increase the demand for research done by public institutions. NRC provides financial support for research projects conducted by small and medium size (less than 500 employee).

Education and training of workforce to properly use modern technology is lacking in food industry compared to other industries such as automobile industry. Due to the use of newer technology a wide gap is created between technology and training of workers.
Nutritional issues are important for the industry. **Nutraceuticals** are also being produced in Ontario, but progress is slow. Overall, Canada is behind USA in this respect. In fortification of food products, juices in particular, USA is leading due to advantages in regulations. Chemical analysis of nutraceuticals are needed as well as improved labelling regulations are required. Products (juice) fortified with nutraceuticals are being produced and fortification to more and more foods is on the horizon; however, the presence of active ingredients in these products is questionable. Therefore, there is a need for new processing methods such as cold processing to preserve the active ingredients while inactivating micriorganisms.

Economic problems: For export, Canadian processed food is more attractive due to low value of Canadian dollar. However, imported equipment, machinery and raw material are more costly.

Energy managements are needed by process and equipment modifications to reduce processing cost.

4.3 Emerging issues

Safety and Quality: Air quality in the plants is required to be maintained particularly where ovens are used. Discharging particles into air is becoming a problem. These particles are more harmful as they cause respiratory problems. Water quality for food processing is also becoming more critical. Effective use of water and reuse of wastewater are needed. Odour and wastes discharged from processing plants is also becoming a major concern.

Sensors for quality attributes and food safety are needed to effectively produce products with consistently high quality and greater consumer acceptance. For this, rapid and in-line methods for food analysis and quality control are required.

Technological Challenge: Computer-dependant technologies continue to be important within the industry. Advances in instrumentation, automation and software, vision systems, and wider implementation of HACCP related quality control systems are all leading to wider use of computer technology. Vision scan and x-ray devices are needed for bruise detection on fresh produce, proper baking of cookies, and detection of worms and blood spots in food products.

Neutraceutical Processing: There seems to be interest in extracting neutraceuticals from soybean, tomato, hemp, etc. Appropriate separation technology is needed to extract active ingredients. Cold processing is required to avoid degradation of active ingredients. Research is also needed in purification and concentration of neutraceuticals.

Wine and beer Industry: Due to the growth of wine and beer industry especially, microbreweries, in Ontario, there are research needs in process engineering area. Micro breweries, are facing some problems such as: how to be profitable, more needs in processing knowledge and expertise, and using old equipment that is less energy efficiency, and costs more to repair.

Byproduct Utilization and solid waste management: Presently byproducts from many food industries are going for animal feeding. Research is needed to utilize the byproducts from corn, apple and grape processing industry.
Economical disposal of wastes is becoming a problem as the land and waterways are limited around the processing plants and strict regulation is being imposed. Cheese whey, soy processing waste, liquid egg processing waste, food packaging materials are some of the major sources. Making value added products from the under utilised or waste material would be an advantage therefore, more research in this area is required.

5.0 REPORT OF ACTION TAKEN ON PREVIOUS YEAR'S RECOMMENDATIONS

ARIO Response to Food Engineering Recommendations

ARIO recognizes the research priorities contained in the recommendations presented by the Food Engineering subcommittee. Research into food processing is supported by OMAFRA through the Food Program of the Enhanced Partnership with the University of Guelph and also through the Special Research and other competitive research programs.

The limited human and financial resources available dictate that all priorities can not be addressed simultaneously. In order to address new issues or expand work in existing priorities research in existing areas must be either scaled back or completed to make the resources available. OASCC committees can assist in this process by identifying research areas which are no longer high priority.

A mechanism has been put in place to redirect resources within the Enhanced Partnership Agreement to high priority areas which are not currently being adequately addressed. Committees will need to identify areas which are the highest priority and also which areas of research can be reduced.

The University of Guelph has developed a food research program for the next four years which was presented to ARIO in April. This proposed program is based on the industry needs as identified by OASCC committees such as your own. The research priorities identified in committee reports are used to determine if the proposed program meets the industry needs and that the proposed allocation of resources is in line with the priority assigned to those needs by the committees.

It was noted that the Food Engineering Research and Services committee submitted their report to the Food Processing Research and Services committee for consideration. We continue to encourage communication and cooperation between committees. As well, we would encourage discussion between the Engineering and Food committees to determine how the Food Engineering Committee can serve the mandate of both committees.

The move of Agriculture and Agri-Food Canada researchers from Ottawa to Guelph and the completion of AAFC new facility will provide further opportunities for increased collaboration between the University of Guelph and federal researchers allowing more efficient use of resources.

Food Research Program 2000-2004

This year the Food Research Program was reviewed and a long term Program has been developed to effectively use resources within the University of Guelph, including clusters funded recently by the Canadian Foundation for Innovation and Ontario Innovation Trust, as well as collaborating organizations (e.g. Agriculture and Agri-Food Canada, Health Canada, Canadian Food Inspection Agency, Guelph Food Technology Centre) to address research priorities of the Ontario Agricultural Services Coordinating Committee (OASCC). Research needs identified through the Food Industry Competitiveness Branch of OMAFRA (as reported in the OFPRSC 1999 Strategic Report for 2000 - 2004) and the Canada Committee on Food, a committee of the Canadian Agri-Food Research Council (CARC) have also been considered.

The following objectives and goals were set for this period (2000-2004)

Objective 1: Ensure safety and improve quality of Ontario food products.

To ensure that Ontario food products maintain their high quality standards in terms of microbial safety as well as sensory and nutritional factors while addressing the concerns of producers, processors and consumers, research efforts are directed to achieving the goals.

Intervention strategies (e.g. changes in management practices, changes in processing procedures or development of novel processing approaches) are central to any successful quality improvement. The fundamental knowledge developed through understanding of relationships between molecular structures and functions of food components related to quality (sensory, microbial safety and nutritional factors) would be used to identify potential intervention strategies. For example, better understanding of how micro-organisms□interact with food components will be used to develop strategies to extend shelf-life while ensuring safety.

The research needs related to Food Engineering are identified in Section 6.0

Objective 2: Develop value-added components in Ontario-grown food products.

Recently, scientists have demonstrated that the consumption of certain foods can have specific health benefits beyond providing essential nutrients, energy and pleasurable sensations. This discovery has revolutionized the field of nutritional sciences (now called nutritional and nutraceutical sciences) and is beginning to have a major impact on the food and agricultural industries in Canada.

Research activities under this goal include isolation of functional components in foods produced in Ontario, analysis of the effects of extraction techniques and processing on the stability and bioavailability of functional components and development of new functional foods and nutraceuticals.

The research needs related to Food Engineering are identified in Section 6.0

Objective 3: Design innovative technologies to manufacture traditional and new food products.

Research activities under this objective focus on developing food manufacturing technologies that are acceptable in terms of sustainability, competitiveness and consumer values. Process design research includes scale-up from laboratory procedures as well as evaluation of process economics at each stage of scale-up. These objectives mainly deal with Food Engineering and the goals are given below.

Goal 3.1 Develop appropriate technologies to extract and stabilize value-added components from Ontario agricultural resources as well as manufacturing waste streams.

In the program, this includes technologies to extract valuable components from unprocessed agricultural materials, recovery of components from manufacturing waste streams, and stabilization of functional components. Extraction technologies include the use of novel solvents such as supercritical carbon dioxide as well as innovative combinations of enzymes and fractionation methods. Process design requires teams of food scientists and engineers since it is critical that separation and stabilization do not degrade functionality. Also it is important to incorporate economic analysis at preliminary design stages. Otherwise, recovery costs may reduce the "value added" to a minimal or negative value.

Goal 3.2 Improve existing and develop new technologies for food preservation.

Food preservation includes post-harvest stabilization and large-scale storage as well as innovative packaging systems to maintain quality and extend shelf life of food products. The design of complete food packaging systems requires integration of post-harvest physiology, preservation methods, microbiology and packaging materials science. Research will focus on packaging performance relative to food quality requirements (including safety and sensory quality) as well as integrated preservation and packaging technologies (e.g. modified atmosphere environments).

Post-harvest research will also focus on understanding and controlling metabolic processes that occur during storage. Fundamental knowledge of postharvest physiology in fruits and vegetables will allow for effective management of storage conditions and/or development of treatments to extend shelf life.

Sub-Committee Response:

This year some of the major research needs were considered in the Food Program 2000-2004. It is a good sign compared with last 4 years. During that period, not much work was supported in the recommended areas. It was frustrating that after spending considerable time by the sub-committee members in developing these priorities no action was taken.

This year like in the last year, sub-committee is providing recommendations project-wise.

Not much work has been done on many past recommendations. Therefore some projects are being recommended again.

Since food industry is the second largest industrial sector in Ontario, and food industry is facing many engineering related problems, more resources are needed for food engineering research.

6.0 STRATEGIC DIRECTIONS/PROBLEMS OR ISSUES/SECTOR PRIORITY

1. Advanced and novel food processes for better productivity, quality and safety of food

One of the process identified is the non-thermal pasteurization of liquid foods using pulsed electrical field. The work is being conducted for the last few years at the School of Engineering, University of Guelph. Several hurdles have been removed. However more work is needed to make this process commercially viable.

Three processes identified are deep-fat frying, pan-frying and baking. Some work on deep-fat frying is in progress at the School of Engineering. Work is needed in the areas of pan-frying of meat patties for E. coli safety, and on baking for better product quality.

High pressure processing (HPP) is becoming an important commercial cold food preservation technology in Europe, USA, and Japan. However, its application is limited in Canada and there is not any commercial or experimental unit in Ontario. This process not only inactivates the microbes but also maintains the quality thus it is good for neutraceuticals and foods fortified with neutraceuticals. The subcommittee recommends this is an urgent need. Collaboration between federal and provincial governments in this area is urged.

Ozone application to fruits and vegetables (reducing waste and chlorine use) and its potential application to grains (to replace CO_2 and Fumigants) to prevent bacteria, fungus and mould is an other area to be investigated. A large quantity of fruit and vegetables is produced in Ontario during the summer. However, these produces can not be economically stored for long time and finding new ways to preserve them at reasonable cost would increase the income to farmers and reduce the cost to consumers. This also cut down on chlorine use and disposal.

The price and the demand for beans grown in Ontario are very low and there is a need for increasing the price and the demand. There are research needs in new product and process developments such as ready to eat meals, easy digestible products, easy cooking products, and uniform dehydration process.

2. Sensors, image processing and automation for higher productivity, safety and quality

In-line sensors for the detection of contaminants and quality parameters in foods are needed for consumer safety and product quality. Three processes were identified for image processing: inexpensive in-line methods for detection of glass pieces in glass containers, small chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans. No work is in progress on these areas.

Three in-line sensors were identified: for microbial detection, moisture at high temperature for baked foods and dough properties. Some work is in progress on microbial sensor in the University of Guelph, but no work is being carried out on other sensors.

3. Neutraceutical processing -- separation, purification and concentration

Work is needed on the development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.) to be used in supplements and in fortified foods. Some work is in progress in the University of Guelph, and AAFC laboratory in Guelph. However more work is needed.
This need was also identified by CARC.

4. Characterization of raw ingredients for quality control in processed foods

No work is in progress in Ontario on this or related topic. There is a need for low cost and high quality locally produced ingredients for small and medium sized companies. Evaluation of raw materials and ingredients for their physical and functional properties are important.

5. Wine and beer industry growth in Ontario requires optimum material handling

Applied research is needed in this area for expanding Ontario wine industry. No work is in progress at present.

6. By products utilization and environmental (waste and air quality) quality

Applied research is needed to develop value added food and non-food product from food waste and reducing air and water pollution.

7.0 RECOMMENDATIONS ARISING FROM THE GAPS/BARRIERS/DEFICIENCIES

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #1

Issue: Advanced and novel food processes for better productivity, quality and safety of food

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO and OMAFRA.

Title: Improved technologies for pasteurization such as non-thermal processes to reduce processing cost and to enhance nutritional and flavour quality, and shelf life.

Details:

The new and improved non-thermal pasteurization processes should increase product quality and process efficiency. Novel technologies are needed to safely extend shelf life without perceptibly altering the natural flavour, composition and taste of foods. The new technologies should maintain product quality standards and integrity, minimize energy utilization, and maximize yields.

The beverage industry has an immediate need for replacing thermal pasteurization as consumers are interested in minimal processed and fresh-like fruit juices. The conventional process is not only energy intensive but denature the products' colour, flavour and vitamin content. There is great need for a non-thermal pasteurization that is safe, energy efficient, economical and does not affect nutrition and flavour. Wine manufacturers are also interested in non-thermal pasteurized grape juice for better flavour of wines.

Background:
The food manufacturing industry is facing increasing global competition, government regulations and consumer demands. These challenges require adoption of new technologies and methodologies to create and sustain a competitive advantage in the market place.

Even a small improvements in manufacturing technology through technological innovation, efficiency improvements or resource utilization would have a large economical effect on food industry given its size. A 1% improvement in productivity by improved and novel technologies will save $50 million per year.

The recommendation should be addressed by research institutions and universities, food industry, and collaborative research between industry and academic researchers. There is some current research activities at the School of Engineering, University of Guelph in this area.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #2

Issue: Advanced and novel food processes for better productivity, quality and safety of food

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC and OMAFRA.

Title: Baking and frying processes modelling to improve baked and fried products' quality.
Details:
Modern cooking systems are becoming complex due to industry's expanding need for higher production, short cooking time, consistency and better quality, higher yield, energy efficiency and versatility. The models will provide a better understanding of the process mechanisms, assist with better design of equipment and process, and will promote the more efficient use of existing equipment. A detailed understanding of the fat transfer profile is of major interest to processors

as consumers are more aware about the amount of fat they consume. Optimization of the process parameters will result in better process control, product quality, and lower fat. Pan-frying process required to be studied with respect to the changing physical properties and chemical composition of beef patties during cooking and consequent microbial destruction.

Heat, moisture and fat transfer within the food and crust formation occur during cooking including deep-fat frying, broiling, baking, pan frying. Cooking is still considered more of an art than a science. For cooking to be adequately controlled, designed and optimized, the food quality kinetics during cooking must be understood. Fried foods constitute a large percentage of the snack food industry. Research on frying has generally concentrated on the kinetics of oil degradation. Little is known about the fat transfer during frying as affected by edible coatings of frozen products. Recent consumer trend toward healthier foods is creating significant pressure to reduce fat in cooked products. Fried foods still contain large amount of fat, in some cases >45%. Excess fat consumption is considered as the key dietary contributor to coronary heart disease and cancer of breast, colon and prostate.

Background:
As the market for fully cooked products continues to expand, modelling and simulation that predict product temperature, cooking yield, and pathogen lethality during cooking will be valuable tools for designing effective and safe thermal processes. With the increasing concern on safety and quality of beef and chicken patties, the importance of prediction of heat and fat transfer, microbial lethality and optimization of pan-frying is evident. The development of in-line sensors and process modelling and optimization will be critical in implementing total quality management (TQM) and HACCP in the food industry. The food industry represents about $5 billion of Ontario's GDP. A 1% improvement in productivity through improved process control represents $50 million.

Collaborative research on these needs is required between researchers from research institutions and universities and food industry.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #3

Issue: Sensors, image processing and automation for higher productivity, safety and quality

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC and OMAFRA.

Title: Image processing for inexpensive in-line methods for detection of glass pieces in glass containers, chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans.

Details:

Baby foods and fruit juices are generally filled in glass containers due to consumer preference. During filling of foods or juices in glass containers at high speed, occasionally, a few glass containers are shattered due to impact. Consequently, a few pieces of broken glass with variant sizes may find their way into the containers during this shattering process. To detect containers that contain glass pieces, a scanning system is needed. For this system to be of practical value it has to be cost effective and fast enough so as to cope with the speed of the filling process. Currently, there are a few systems in the market. These systems are based on x-ray technology. Unfortunately, the speed and high cost of such systems are among the major factors that hinder their use in these applications. Since popularity of ground chicken products are increasing, the demand for deboned chicken is also increasing. Detection of small chicken bones in deboned meat is difficult. An in-line detection system is needed so that these small pieces of bones can be separated. Similarly sclerotia due to black fungus in white-beans reduces the quality of the product. Image processing based method seems to be suitable for the separation of sclerotia.

Background:

The development of in-line image processing detection devices for above-mentioned problems will be critical for food safety and quality, and in implementing total quality management (TQM) and HACCP in the food industry. The food industry represents about $5 billion of Ontario's GDP. A 1% improvement in productivity through improved process control represents $50 million.

Collaborative research on these needs is required between researchers from research institutions and universities and food industry.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #4

Issue: Neutraceutical processing -- separation, purification and concentration

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC and OMAFRA.

Title: Development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.) to be used in supplements and in fortified foods.

Details:

The separation, purification and concentration of neutraceuticals and functional foods are critical for their quality and functionality. Neutraceuticals and functional foods will be used in supplements and in fortified foods. Suitable process is needed for isolating isoflavones from soybeans. A significant body of work is required to understand the properties of neutraceuticals and to develop process technologies that ensure the functionality of these ingredients remains intact. This is an area of high interest to many in the food business.

Background:

The neutraceutical market is increasing day by day. If Canadian food industry will not develop the products containing neutraceuticals, then consumers will get the foods fortified with neutraceuticals from USA or other countries.

This recommendation should be addressed by the industry, research institutions and academic researchers.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #5

Issue: Sensors, image processing and automation for higher productivity, safety and quality

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC, CCF and OMAFRA.

Title: In-line sensors for microbial detection, moisture at high temperature for baked foods and dough properties

Details:

Due to complex nature of food and its processing, in-line sensing of food quality and microorganisms is needed. Inexpensive and reliable sensors and methods are needed for these. Process controls need measurement of key process parameters to determine the current operating conditions. In-line sensors for monitoring many food quality and safety parameters are not available.

Control of optimized processes is presently limited not by lack of computer or control devices, but by lack of sensors to measure specific food properties. Development of suitable sensors is needed for control systems to measure the critical process parameters and assist in their control.

The lack of sensors and control systems for food processes is a major impediment to development of a fully automated food processing system.

Artificial neural network (ANN) is a useful tool for real-time prediction of data and for online process control.

Background:

The development of in-line sensors, ANN and process modelling and optimization will be critical in implementing total quality management (TQM) and HACCP in the food industry. The food industry represents about $5 billion of Ontario's GDP. A 1% improvement in productivity through improved process control represents $50 million.

Collaborative research on these needs is required between researchers from research institutions and universities and food industry.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #6

Issue: Characterization of raw ingredients for food quality control in processed foods

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC, CCF and OMAFRA.

Title: Raw material characterization for product quality.

Details:

There is quite a large variability in raw food material (cereals) from year to year and batch to batch. These variabilities are affecting functionality of the ingredients particularly for cereal industry manufacturing breakfast cereals, breads, cookies, etc. This research will minimize undesirable changes due to processing, and will improve productivity. The present lack of sufficient data on physical properties of basic food ingredients and products has limited the application of many well established engineering principles.

Background:

The quantification and modelling of food properties and processes will be critical in improving the productivity in food industry. Based on the improvement in the productivity by this research of 0.5%, the net saving to the food industry will be $25 million per year.

This recommendation should be addressed by the industry, research institutions and academic researchers.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #7

Issue: Wine and beer industry growth in Ontario requires optimum material handling

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC, FCC and OMAFRA.

Title: Optimizing material handling in wine industry.

Details:

Due to the rapid growth of wine and beer industry in Ontario in recent years, there is a need to improve its productivity. One of the area suggested is the optimization of material handling so that process efficiency can be improved, byproducts can be minimized and utilized, and processing wastage can be minimized.

Background:

The optimization of material handling will be critical in improving the productivity in wine industry. Applied research is needed in this direction so that the wine industry can use the information without doing in-house research or trial approach.

Some research is also needed to minimize and utilize processing waste from the wine industry.

This recommendation should be addressed by the industry, research institutions and academic researchers. It is difficult to estimate the economical impact on the wine industry.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #8

Issue: Waste management and air and water pollution control.

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC, FCC and OMAFRA.

Title: By-products utilization, waste management and air and water pollution control.

Details:
Economical disposal of wastes is becoming a problem as the land and waterways are limited around the processing plants and strict regulation is being imposed. Presently byproducts from many food industries are going for animal feeding. Research is needed to utilise the byproducts from corn, apple, and grape processing industry. Other sources of waste are cheese whey, soy processing waste, liquid egg processing waste, food packaging materials are some of the major sources. Processing waste can be minimised by reducing the byproducts generation and utilising them to produce value added food and non-food products.

Water quality and air quality for food processing is also becoming more critical. Effective use of water and reuse of wastewater are needed. Removal of Odour and particles from the air coming from food processing plant is becoming very important.

Background:
Producing value added food and non-food products from the under utilised or waste material and finding economical ways to reduce water and air pollution generated by the food industry would be an advantage to the industry therefore, more research in this area is required

This recommendation should be addressed by the industry, research institutions and academic researchers. It is difficult to estimate the economical impact on this.

Ontario Agricultural and Food Engineering Research and Services Committee
Food Engineering Subcommittee

Recommendation #9

Issue: Process development, product safety, good manufacturing practices for small processors

OASCC linkage: Food processing committee.

Target agencies: Recommendation to ARIO, AAFC, FCC and OMAFRA.

Title: Process development for new products for small processors

Details:

Due to the rapid expansion of small food processors who has very little capital to invest in short term R&D and long term high risk research, there is a need for conducting research at public research institutions. These research institution should focus on process and product development suited for small processors and to produce small scale speciality products to increase the profit. Lack of research support would make the long term survival of these processors questionable.

Background:
The statistics shows that small companies are hiring more people and the long term survival of small food processors would be an added benefit to the economy of the province.

This recommendation should be addressed by the industry, research institutions and academic researchers.

8. SUMMARY OF DISTRIBUTION OF RECOMMENDATIONS

To Agencies

Recommendation	AAFC	ARIO	CCF	CARC	OMAFRA	Other
1. Improved technologies for pasteurization such as non-thermal processes to reduce processing cost and to enhance nutritional and flavour quality, and shelf life		X			X	
2. Baking and frying processes modelling to improve baked and fried products' quality	X	X			X	
3. Image processing for inexpensive in-line methods for detection of glass pieces in glass containers, chicken bones in mechanically deboned chicken and sclerotia (black fungus) in beans	X	X			X	
4. Development of efficient methods for separation, purification and concentration of neutraceuticals from various sources (soybean, tomato, hemp, etc.)	X	X			X	
5. In-line sensors for microbial detection, moisture at high temperature for baked foods and dough properties	X	X	X		X	
6. Raw material characterization for food product quality	X	X	X		X	
7. Optimizing material handling in wine and beer industry	X	X	X		X	
8. By-products utilization, waste management and air and water pollution control.	X	X	X		X	
9. Process development for new products for small processors	X	X	X		X	

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ONTARIO LIVESTOCK ENGINEERING
RESEARCH AND SERVICES COMMITTEE

2000 ANNUAL REPORT
TO

ONTARIO AGRICULTURE AND FOOD
ENGINEERING
RESEARCH AND SERVICES COMMITTEE

DECEMBER 7, 2000

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EXECUTIVE SUMMARY

The Livestock Engineering Sub-Committee of the Ontario Agriculture and Food Engineering Research and Services Committee has listed the research and service needs of Ontario for 2000.

The following items require a high priority:

1. **Development of Standards for the Construction of Manure Storage Structures and Manure Handling Systems:** Continued concern exists surrounding the need for manure storage and handling systems to be leakproof. Currently, section 2.2.1.13 of the National Farm Building Code only discusses the construction of manure tank walls and lids. The proposed Ag. Operations Act may make it necessary to pursue this through an emergency amendment to the Ontario Building Code. Full scale testing is needed to assess current construction techniques and their ability to produce leakproof manure storage structures and transfer systems.

2. **Air Quality in Livestock Buildings**: Manure odours and gases, dust and dirt, and noise all contribute to the negative perception of air quality in livestock barns for both the animals and the farm workers. Existence of poor air quality is substantiated by the excessively high levels of chronic respiratory problems observed in farm workers. Poor air quality is one of the main causes of high labour turn over on livestock farms. Hazardous gases, including silo gas, hydrogen sulphide gas and carbon dioxide have on occasion accumulated to toxic levels and caused fatalities to humans and/or farm animals. Unfortunately, these gases can develop very quickly or go unnoticed until it is too late. Losses of farm animals (particularily swine) continue to occur all too often. It is also expected that there are numerous cases of injuries to the lungs of both humans and animals from sub-lethal levels of these noxious gases.

3. **Corrosion and Deterioration of Agricultural Building Components**: Steel reinforcing in silos, manure tanks and slats, as well as corrosion and deterioration of other building components can cause injury or loss of human life and livestock fatalities as well. This item includes buildings that enclose high humidity and corrosive environments (eg. composting operations). Ultimately, the National Farm Building Code may specify situations where specialized materials or coatings should be used. It is important to form partnerships with industry to fund and carry out this research.

INTRODUCTION

This report is a summary of the discussions held by our sub-committee, on November 23, 2000, Shurgain Research Farm, Burford, ON. At that time current research was reviewed, new areas of concern were noted and a listing of research and service needs in the livestock engineering area were organized.

SUB-COMMITTEE ACTIVITIES:

Activities: During the past year, we have had one meeting of this sub-committee. Attending this meeting were: Members: John Johnson (Chair), Fred Groenestege, Bob Robson and Dale Thompson. Other members and Paul Brine were not able to attend due to other commitments.

Committee Membership: Dale Thompson, B.S.M. farm equipment, has agreed to participate on this committee.

Several names were suggested as possible future members for this committee. They included; David Waud (Sun-North Systems), Ray Jacobs (Landmark Builders Ltd.), Ron MacDonald (Agviro Inc.). Fred Groenestege and Jim Cooke who were scheduled to leave our committee after our 2000 meeting, expressed an interest in continuing to participate, at least for another year.

Review of Current Listing:

At our subcommittee meeting at the Shur-Gain Research Farm, the following items were discussed:

Construction Concerns with Manure Storage – Continued discussion was held about the need for the entire manure handling system including the plumbing connections to be leakproof. The proposed Agricultural Operations Act may make it necessary to pursue this though an emergency amendment to the Ontario Building Code. Currently, section 2.2.1.13 of the National Farm Building Code only discusses the construction of manure tank walls and tops.

> ***Action:** John Johnson, with the assistance of Chung Li, MMAH and Dr. Jan Jofriet would look at this section in more detail and suggest some clarification on the wording and/or expand the definition of manure storage system. Fred Groenestege and Harold House have also provided comments regarding the proposed wording.*

Corrosion of Truss Gusset Plates - In November 1997 our committee requested a new clause be added to the National Farm Building Code requiring all metal truss gusset plates to be protected by a suitable coating when used in a corrosive atmosphere. In April 1998 the Standing Committee on Structural Design replied that the matter warranted some action but required "something more specific and enforceable than proposed by Mr. Huffman". It is felt that our committee should respond in order to keep this concern and request for Code change active. The letter from the Code committee suggested that the Truss plate Institute of Canada be consulted to ensure that any proposed solution is achievable by the industry. As well, an official form for

"Proposed Change to a National Code Document" was attached which basically asks for the wording for the change or addition and the justification for the change.

> ***Action:*** *John Johnson and Harry Huffman have asked for input from the Truss Plate Institute of Canada and are awaiting their reply (Letter sent Nov.1, 1999). When this is obtained we will complete the necessary paper work and re-submit to the Canadian Commission on Building and Fire Codes.*

Animal Comfort, Care, Health/Disease - Jim Cooke led discussion objecting to the presentation of this particular item. Jim feels that there is sufficient research conducted to disprove much of the intent of this item. Jim contacted Dr. David Price, New Mexico and suggested communication with John Johnson. Dr. Price feels that subtherapeutic use of anitbiotics is not as large a concern as was previously stated in this item. Small doses of antibiotic will allow some naturally resistant organisms to exist. Massive doses of antibiotics will kill all non-resistant organisms, leaving only the resistant organisms. The consensus of committee members was that a major rewrite should take place on this item.

> ***Action:*** *Jim Cooke will prepare new wording for this item.*

INDUSTRY/SECTOR SCAN:

Major Accomplishments since last report:

Air Quality in Livestock Buildings:
☐ air quality in livestock buildings (Univ. of Saskatchewan - 0.1 py (person years))
☐ evaluation of floor applied mineral oil in reducing respiratory dust (Univ. of Alberta - 0.1 py)

Corrosion and Deterioration of Agricultural Building Components:
☐ corrosion and deterioration of agricultural building components (Univ. of Guelph 0.35 py)

Manure tank design:
☐ Innovative design of manure storage tanks (Univ. of Manitoba - 0.54 py)
☐ A letter to the Standing Committee on Structural Design pertaining to the wording of the National Farm Building Code is proposed. This will be forwarded to the Standing Committee in 2001. As well, an emergency amendment to the Ontario Building Code will be made in 2001.

Animal Comfort:
☐ A behavioural and environmental study to develop improved gestation and farrowing accommodation for sows and litters (Lennoxville, Que - 2.0 py)
☐ Using natural convection to lower attic temperatures in controlled environment buildings (Univ. of Manitoba - 0.08 py)
☐ Low Energy Input Swine Housing Systems (Winnipeg, Manitoba - time unknown)

Corrosion of Roof Truss Gusset Plates - Clarification and a letter of support from the Truss Plate Institute of Canada is forth-coming.

Technical Information for the Construction Industry:
☐ Structural behaviour of nail-laminated posts (Univ. of Manitoba - 0.11 py)

CURRENT STATE OF THE INDUSTRY/RURAL SECTOR:

Beef:

☐ the Ontario beef industry is moving into a time of optimism and growth. The industry is consolidating and being directed by stronger hands. The Ontario Cattle Feeders Association (approx. 3 years old) is showing a marked effect on the industry.
☐ much of the cattle feeding is done on contract

Dairy:

☐ optimism in the industry remains
☐ the price of quota continues to rise – variable, but averaging $20,000/kg of butterfat
☐ barns continue to be constructed, both by immigrant producers, and established producers
☐ Commercial robotic milking installations are becoming more common. A dozen or more farms are now operating exclusively with milking robots. Several companies are offering robots for sale: Lely, Prolion, Delaval, and Surge-Westfalia.

Swine:

☐ barns continue to get bigger in size: 2400 sow barns and 2000 finishing barns are becoming the norm
☐ society's reaction to proposed swine barns being built is becoming widespread.
☐ municipalities are reacting with restrictive by-laws in an attempt to minimize 'large' barns
☐ facilities with leaking manure tanks and manure transfer piping systems have been encountered.

Sheep and Goats:

☐ sheep production is increasing slightly, some as milking herds
☐ there is a continued increased interest in goat operations.

Poultry:

☐ producers continue to be very optimistic about this industry and seem prepared to invest big dollars in quota and new facilities. Interest continues to come from older dairy farmers who are switching between the two quota systems. Extremely high quota prices continue (broilers @ $42/unit; egg quota @ $80+/hen; turkeys @ $2.60/kg).
☐ Ontario has approximately: 1100 broiler producers; 200 pullet producers; 500 egg laying hen producers; and 160 turkey producers.

Fruit and Vegetables:

☐ the greenhouse industry continues to expand, particularly in the Leamington area (cucumbers and tomatoes) and in Niagara (flowers)
☐ non-traditional niche-market crops are being grown with unfamiliar post-harvest requirements

Grains and Forages:

☐ construction of tower silos remains at an all time low
☐ silo deterioration continues to be an ongoing challenge
☐ plastic from wraps, tubes, individual bags, etc. present local problems for recycling or disposal

Building Engineering:

☐ snow loading concerns have surfaced in large farm buildings. Recent collapse of 10-12 large buildings has sparked interest in the design process used for farm roofs.
☐ building construction is still relatively active in Ontario. Typically, new livestock buildings

are tending to be very large. Engineering is more prevalent in these larger structures. A larger contractor may have an on-staff engineer or may hire a private consultant to provide engineering details. Building officials are happy to share some of the responsibility for the structure with an engineer.

- ☐ municipal restructuring means fewer, better trained building officials. There are currently less than 500 municipal building officials serving rural areas. It is expected that there will be approximately 350 by 2003. This is bringing about more even application of building codes in Ontario. OMAFRA continues its education program, directed toward the improved application of building codes in Ontario.

Environmental:

- ☐ A large number of swine, poultry and dairy operations are still being constructed in Ontario. Nutrient Management Plans are commonly being required by municipalities. Farmers are anxiously awaiting the announcement of the proposed Agricultural Operations Act. Public interest groups are vocal against large livestock operations being constructed in their communities. Some municipalities have placed an interim control bylaw in effect to limit the construction of larger livestock operations until the Ag. Operations Act comes into being.

EMERGING ISSUES:

- ☐ the use of safety railing around openings in manure tanks and transfer pumps need to be addressed
- ☐ recent building collapses due to significant snow loading has resulted in the need to rethink design methodology for farm roof construction.
- ☐ preventing manure leakage from barns and storages
- ☐ manure handling problems when sanding bedding is used in free-stalls
- ☐ power driven nails do not have the shear strength or holding power of spiral and common nails.
- ☐ disease control on new large swine operations
- ☐ covered manure storages for poultry
- ☐ more cold storages will be used year round to spread out costs. This may create some vapour barrier problems with reversing vapour pressure gradients
- ☐ need for improved aeration systems for flat grain storages
- ☐ producers believe there is a need for research to provide information and technology to prevent or alleviate concerns regarding animal welfare and environmental sustainability in all sectors.
- ☐ questions still remain regarding the use/operation of tunnel ventilation systems
- ☐ what depth of manure storage under a barn floor is acceptable?
- ☐ time commitment, and type of cleaning equipment being recommended for cleaning barns between animal cycles. There is some speculation on the use of robotics for this task

New Ideas for Research and Service:

- ☐ Require full-scale building testing of manure storage and handling components to prove or disprove the integrity of current building techniques
- ☐ Require development of comprehensive standards for all aspects of manure storage and handling
- ☐ Require an improved, comprehensive design model to describe snow load distribution on large farm structures
- ☐ Investigate the use of a spray bar to reduce H_2S development in tanker or manure tank
- ☐ Further research is needed to measure and improve mixing accuracy of medicated feeds, low energy rations, etc.
- ☐ Require information regarding the strength of nailed joints

☐ Require information regarding the factors that affect tunnel ventilation
☐ Require increased odour control research for both inside barn air quality as well as around the buildings
☐ beef producers need to be able to lower costs of production by 20%. Simplified structures would assist. Some features might be modular construction, a roll-off roof, combination manure systems

STRATEGIC DIRECTIONS/PROBLEMS OR ISSUES/SECTOR PRIORITIES

RECOMMENDATION NUMBER: 1

ISSUE: Development of Standards for the Construction of Manure Storage Structures and Manure Handling Systems

SOURCE: Livestock Engineering Sub-committee

OASCC LINKAGES: Animal Committee

TARGET AGENCY: Agricultural Research Institute Of Ontario,
Canadian Agricultural Research Council
Ontario Ministry of Agriculture, Food & Rural Affairs

Details: Techniques used in the construction of manure storage structures, transfer piping, etc. have been found in some situations to be lacking quality of workmanship. The proposed new Agricultural Operations Act will require that appropriate standards be developed to ensure that construction quality is high.

Research is needed:

1. To assess current construction techniques and to verify the integrity of the manure storage system in a full scale building test.

Applied Research is needed:

2. To develop standards for steel, concrete, earthen storages, synthetic and clay liners, transfer piping, etc.
3. To develop protocols that will ensure a uniform and appropriate level of building inspection.
4. Changes to the National Farm Building Code are necessary to ensure that all components of the manure storage and handling system are regulated.

Background: Issues related to integrity of manure storage and transfer plumbing have been encountered in the past several years. There are concerns that construction techniques used on a significant number of projects are allowing manure to escape into local groundwater reserves or nearby field drains. We need to know if shrinkage cracking in concrete floors and walls will allow the passage of manure in significant quantity. As well, construction joints need to be evaluated for their ability to protect against manure leakage. A full-scale project, utilizing a newly constructed livestock facility would provide much needed data to assist us in determining the integrity of current construction methods.

Cost/Benefit: It is estimated that the research needed to address these concerns would potentially cost approximately $100,000. Ministry of the Environment has estimated that the cost of cleaning up liquids that spill into the environment is approximately $40-50 per gallon. This means that if 2000-2500 gallons of manure leakage could be reduced by this project, the cost would be reclaimed. It is estimated that the leakage from livestock operations in Ontario exceeds this amount significantly. Payback from this project could be very significant. Remedial measures for existing operations would have the largest impact on the environment. Since it is difficult to put a price on clean water, it is safe to say that research dollars spent on this item would be well placed.

Resources: Ontario Pork has already conducted some research in this area and have committed to provide funding to carrying out further research. OMAFRA and Ridgetown College of Ag. Technology have also made a commitment to participate in research in this subject area. OMAFRA has been involved in the preparation of standards for components of manure storage and handling systems. It is anticipated that this involvement will continue.

RECOMMENDATION NUMBER: 2

ISSUE:	Air Quality in Livestock Buildings
SOURCE:	Livestock Engineering Sub-Committee
OASCC LINKAGES:	Animal Committee, Soil Water and Air Committee
TARGET AGENCY:	Agricultural Research Institute Of Ontario Canadian Agricultural Research Council Agriculture & Agri-Food Canada

AIR QUALITY IN LIVESTOCK BUILDINGS

Details: Manure odours and gases, dust and dirt, and noise all contribute to poor air quality in livestock barns for both the animals and the farm workers. Poor air quality has been verified by the excessively high levels of chronic respiratory problems observed in farm workers. Air quality is one of the main causes of high labour turn over on livestock farms. Hazardous gases, including silo gas, hydrogen sulphide gas and carbon dioxide have on occasion accumulated to toxic levels and caused fatalities to humans and/or farm animals. It is also expected that there are numerous cases of injuries to the lungs of both humans and animals from sub-lethal levels of these noxious gases.

Research is Needed:

1. To study means of reducing the level of air contaminants found in barn environments.
2. To develop improved manure storage systems and management, handling, processing and disposal to reduce hazardous gas generation and minimize odour problems.

3. To determine the chronic effects of sub-lethal gas levels on both humans and livestock and evaluate the long term effects of exposure to these hazardous gases.
4. To determine the short and long term effects of barn noise on humans and livestock.

Applied Research is Needed:

5. To agree on practical and achievable Threshold Limit Values (TLV) for the various air pollutants and combinations of same encountered inside farm buildings.
6. To measure the effect of various additives to the barn environment, feed or manure gutters on subsequent air quality and odour control.
7. To study under-floor ventilation with regard to improved odour control in the animal environment.
8. To develop a thorough evaluation and testing program for warning devices which alert farm personnel that one of the hazardous gases is at a dangerous level.
9. To develop appropriate and practical information for dealing with hazardous gases found at dangerous levels in the animal environment or feed storage area.

Background: Work is still required to develop appropriate strategies for dealing with the various air pollutants, odours and noise levels found in livestock barns. Today's farm workers spend most of their time inside livestock buildings, feed and grain storages as well as operating noisy machinery. They are exposed to high concentrations of different organic dusts such as grain dust, animal epithelia, hair, proteins from urine and feces, mites, bacteria, endotoxin and mold spores. Also, these particles are associated with various toxic gases such as ammonia, hydrogen sulphide, carbon monoxide, etc.

Several of these toxic gases are either odourless or have the ability to paralyse the nervous system and thus are hard to detect when present at harmful concentrations. As farming operations become larger, more hired labour is employed and this increases the chance of short-cuts or misunderstood safety procedures. With several gases involved, more than one warning device may be needed to cover all of the needs of a particular environment. Any such warning device must be reliable over time when located in such a harsh building environment. This type of gas sampling equipment already exists but needs to be evaluated and/or adapted to suit the specific needs of animal environments. Cost will be an important factor in convincing farmers to install these devices. Many producers inquire about chemical additives to the feed, water or manure storage which might reduce odours and toxic gases. Some work is being done by Agriculture Canada, Ridgetown Agricultural College, University of Saskatchewan and Iowa State University, however much is still unknown about the effectiveness of these additives. There may be opportunities for gas and odour reduction within the animal environment with alternative manure handling, processing and disposal systems. There is no known work in this area.

Cost/Benefit: From research work done in Europe and the USA, it has been estimated that 25% to 40% of all the livestock producers and their family members, as well as their farm workers suffer to varying degrees from bronchitis, occupational asthma, organic dust toxic syndrome or general irritation of mucosal membranes due to the poor air quality inside livestock buildings. Applying this estimate to Ontario, there would be between 30,000 and 50,000 people suffering from poor indoor air quality on dairy, beef, swine and poultry farms. It is extremely difficult to evaluate the cost to society because of a reduction of productivity by workers' absenteeism and medical care services directly related to barn air quality. Additionally, it is impossible to assess the cost or loss of revenue encountered by producers because of the difficulty in recruiting, training and maintaining reliable farm workers.

The presence of toxic gases is a human and animal safety issue that is difficult to quantify in dollars. If some animals are killed due to exposure to H_2S gas, not only is there the direct animal losses, but also the down time while another group of animals is raised on farm or purchased to replace those lost. Manure gas, silo gas and carbon dioxide (sealed silo) have all claimed human lives on farms. What is the value of a human life? If a simple gas detector could be marketed for a reasonable cost, along with a proven procedure for reducing hazardous gas levels, it would significantly reduce the number of animal and human respiratory injuries and possible fatalities.

Resources: The University of Guelph, Prairie Swine Research Centre, University of Alberta and University of Saskatchewan have all done some work with air pollutants in livestock buildings but much more work is required. An interdisciplinary task force of agricultural engineers, researchers, veterinarians, physicians and occupational health specialists should be assembled to address threshold limit values for indoor air contaminants, odours and noise levels in farm buildings.

Both Agriculture Canada and OMAFRA have done some research and extension in the areas of manure and silo gas. As well, the University of Guelph, OMAFRA, Prairie Swine Research Centre and the University of Saskatchewan have all done some studies on air contaminants and dust in livestock environments. More needs to be done with commercial scientific instrument companies that already market gas detection equipment. Similarly, it may be possible to co-operate with chemical or feed companies regarding the potential for additives.

RECOMMENDATION NUMBER: 3

ISSUE: Corrosion of Metal Building Components

SOURCE: Livestock Engineering Sub-Committee

OASCC LINKAGES: Animal Committee, Horticultural Crop Committee

TARGET AGENCY: Agricultural Research Institute Of Ontario,
Canadian Agricultural Research Council
Agriculture & Agri-Food Canada

CORROSION AND DETERIORATION OF AGRICULTURAL BUILDING COMPONENTS

Details: Corrosion problems are evident in some farm structures that could affect their structural integrity. Reinforcing steel in cast-in-place silos and beef and swine floor slats have shown deterioration which could lead to structural failure. In under-floor manure storage structures, manure gas and other air contaminants are accelerating the corrosion and deterioration of all metal components and building equipment. Composting structures are showing corrosion on unprotected metal components after a relatively short time. Also, it appears that some wood preservatives hasten corrosion of the structural fasteners used to connect building members.

Research is Needed:

1. To study the relationship between various odours and gases and moisture levels found in typical livestock environments (also composting structures) and the amount of corrosion occurring on the metal building components.
2. To determine the relationship between various wood preservatives and the amount of corrosion occurring on the metal fasteners connecting these members in a farm building.
3. a) To determine the feasibility of using a steel coating and/or concrete additives to inhibit the corrosion of reinforcing steel in such adverse situations as slatted floors, silos and manure storage.
   b) To determine the feasibility of using concrete sealants and coatings that may reduce concrete deterioration which in turn will protect the reinforcing steel.

Background: Silage juices and liquid manure are able to attack the concrete and over time penetrate to the reinforcing steel which in turn corrodes very quickly. The agricultural industry needs a more durable concrete product. Should coated reinforcing bars, concrete additives, coatings and sealants be used, alone or in combination? Concrete slat deterioration has become a significant problem.

The combination of various gases along with higher humidity levels found in livestock barns tend to corrode all metal components of the building and equipment. Proper ventilation plays a role, but to what extent? A field study by OMAFRA revealed that almost half of the livestock buildings investigated had moderate to severe corrosion occurring on the metal gusset plates.

Wood preservatives have been used with good success to protect the building members from deterioration. Concern has now been raised that some preservatives seem to cause an accelerated corrosion of the metal fasteners connecting these treated members in a typical farm building. The farm building industry needs to know which preservatives should be recommended or whether the fasteners need to be coated to prevent this corrosion process.

Cost/Benefit: In 1994, the cost of depreciation on all Ontario agricultural structures was $234.2 million. As well, $130.24 million was spent on building repairs. Since agricultural structures may need to be repaired or replaced prematurely because of this deterioration, these costs could be substantial. On average, corrosion could account for a 10% loss of expected building life. It is estimated that the value of Ontario farm buildings is $10 billion and the average life expectancy of a farm building is 25 years. As a result of corrosion, if the building lasts for only 22.5 years, this results in an annual cost of $44 million.

Livestock housing costs account for 10-20% of the total cost of production. Any shortening of the service life will increase these costs. In addition, if there is a structural failure, there may be additional financial hardship and potential for both human and animal injury or fatality. It is unlikely that any research recommendations concerning suitable coatings, sealants or concrete additives would increase overall building construction costs by more than 5%. If the value of agricultural structures in Ontario is $10 billion, and their life is 22.5 years, approximately $444 million is spent on new construction annually. If the cost to resist corrosion in these structures is 5 percent, this would amount to an annual cost of $22 million.

Therefore the cost/benefit ratio is 22/44 = 1:2

Resources: O.M.A.F.R.A. has evaluated several coatings for use on concrete silo walls. All Ontario concrete slat manufacturing plants are now certified by CSA which should ensure a quality slat for all new buildings. Concrete slat manufacturers are promoting several different approaches to providing increased durability. It is important for cooperative research to take place with these manufacturers. Additionally, the steel industry has good data available on coated reinforcing steel and may wish to collaborate on this type of work. Similarly, the steel industry should expect to work with researchers and the chemical industry to establish recommendations concerning the use of various coatings on metal components in corrosive environments.

SUMMARY OF DISTRIBUTION OF RECOMMENDATIONS FOR 2000

RESEARCH AND DEVELOPMENT:

	To Agency(ies)

Recommendation	AAFC	ARIO	CC	CARC	OMAFRA	OTHER
Development of Standards for the Construction of Manure Storage Structures and Manure Handling Systems		X	X	X	X	
Air quality in livestock buildings	X	X	X	X		
Corrosion And Deterioration Of Agricultural Building Components	X	X	X	X		

APPENDIX II Subcommittee Membership 2000
(please see proposed list for 2001 at end of document)

Organization	Name	Contact Information	Term End
OMAFRA	John Johnson (Chair)	OMAFRA, 667 Exeter Rd. LONDON, ON N6E 1L3 Ph. 519-873-4096 Fax 519-873-4062 jjohnson@omafra.gov.on.ca	Passed expiry date
Univ. of Guelph	Dr. Jan Jofriet	University of Guelph, School of Engineering, GUELPH, ON NIG 2WI Ph. 519-824-4120 Ext. 3642 Fax 519-836-0227 jjofriet@uoguelph.ca	2001
Private Sector	Jim Cooke	R.R.#1 Walkerton, ON N0G 2V0 Ph. 519-881-1188 Fax 519-881-3628 redbaron@bmts.com	2001
vate Sector	Fred Groenestege	Fred Groenestege Const. Ltd. R.R.#1, SEBRINGVILLE, ON N0K 1X0 Ph. 519-393-6579 Fax 519-393-6532 fredg@fgc.ca	2001
AFRA	Dr. Neil Anderson	Manager, Health Management OMAFRA 2nd Floor, Wellington Place, R.R.#1 FERGUS, ON N1M 2W3 519-846-0965 Fax 519-846-8101 nanderso@omafra.gov.on.ca	2001
Private Sector	Dale Thompson	BSM Farm Equipment	2003
Shur-Gain Agresearch	Bob Robson	R.R.#3, Burford, ON N0E 1A0 Ph. 519-424-2550 Fax 519-424-2570 shurgain@oxford.net	2002

2000 COMPLETE LIST OF LIVESTOCK ENGINEERING RESEARCH AND SERVICE NEEDS (in order of priority)

1. DEVELOPMENT OF STANDARDS FOR THE CONSTRUCTION OF MANURE STORAGE STRUCTURES AND MANURE HANDLING SYSTEMS

Techniques used in the construction of manure storage structures, transfer piping, etc. have been found in some situations to be lacking quality of workmanship. The proposed new Agricultural Operations Act will require that appropriate standards be developed to ensure that construction quality is high.

Research is needed:

1. To assess current construction techniques and to verify the integrity of the manure storage system in a full scale building test.

Applied Research is needed:

2. To develop standards for steel, concrete, earthen storages, synthetic and clay liners, transfer piping, etc.
3. To develop protocols that will ensure a uniform and appropriate level of building inspection.
4. Changes to the National Farm Building Code are necessary to ensure that all components of the manure storage and handling system are regulated.

*****

2. AIR QUALITY IN LIVESTOCK BUILDINGS

Manure odours and gases, dust and dirt, and noise all contribute to poor air quality in livestock barns for both the animals and the farm workers. Poor air quality has been verified by the excessively high levels of chronic respiratory problems observed in farm workers. Air quality is one of the main causes of high labour turn over on livestock farms. Hazardous gases, including silo gas, hydrogen sulphide gas and carbon dioxide have on occasion accumulated to toxic levels and caused fatalities to humans and/or farm animals. It is also expected that there are numerous cases of injuries to the lungs of both humans and animals from sub-lethal levels of these noxious gases.

Research is Needed:

1. To study means of reducing the level of air contaminants found in barn environments.
2. To develop improved manure storage systems and management, handling, processing and disposal to reduce hazardous gas generation and minimise odour problems.
3. To determine the chronic effects of sub-lethal gas levels on both humans and livestock and to evaluate the long-term effects of exposure to these hazardous gases.
4. To determine the short and long term effects of barn noise on both humans and livestock.

Applied Research is Needed:

5. To agree on practical and achievable Threshold Limit Values (TLV) for the various air pollutants and combinations of same encountered inside farm buildings.
6. To measure the effect of various additives to the barn environment, feed or manure gutters on subsequent air quality and odour control.
7. To study under-floor ventilation with regard to improved odour control in the animal environment.
8. To develop a thorough evaluation and testing program for warning devices which alert farm personnel that one of the hazardous gases is at a dangerous level.
9. To develop appropriate and practical information for dealing with hazardous gases found at dangerous levels in the animal environment or feed storage area.

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3. CORROSION AND DETERIORATION OF AGRICULTURAL BUILDING COMPONENTS

Corrosion problems are evident in some farm structures that could affect their structural integrity. Reinforcing steel in cast-in-place silos and beef and swine floor slats have shown deterioration which could lead to structural failure. In under-floor manure storage structures, manure gas and other air contaminants are accelerating the corrosion and deterioration of all metal components and building equipment. Composting structures are showing corrosion on unprotected metal components after a relatively short time. Also, it appears that some wood preservatives hasten corrosion of the structural fasteners used to connect building members.

Research is Needed:

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3. a) To determine the feasibility of using a steel coating and/or concrete additives to inhibit the corrosion of reinforcing steel in such adverse situations as slatted floors, silos and manure storage.
    b) To determine the feasibility of using concrete sealants and coatings that may reduce concrete deterioration which in turn will protect the reinforcing steel.

*****

4. LIVESTOCK BUILDING DESIGN, CONSTRUCTION and HUSBANDRY SYSTEMS RELATIONSHIP TO HUMAN HEALTH ENHANCEMENTS (workplace)

Livestock producers should know what renovations to existing buildings, or changes to new animal housing would enhance livestock immunity, and would improve working conditions for workers within the facility.

Research is needed:

1. To identify the design, construction and husbandry systems in livestock buildings that compliment high livestock health and performance.
2. To identify the design, construction and husbandry systems that contribute to disease and impaired performance.
3. To develop practical and economical modifications to existing husbandry systems or create new husbandry systems within livestock buildings to enable high livestock health and performance.
4. To identify design, construction and husbandry systems that minimize disease transmission. (Conversely, to identify design, construction and husbandry systems that contribute to the spread of infectious diseases.)
5. To look at the feasibility of creating a centre for livestock husbandry planning to enable dialogue between scientists in the disciplines of engineering, waste management, nutrition, veterinary medicine, economics, and human medicine, directed at livestock housing systems, animal and human health, with the goal of enhancing animal and human health.

*****

6. ICE PRESSURES FOR MANURE TANK DESIGN

Based on the findings of field surveys in the winters of `94-`95 and `95-`96, OMAFRA standard designs for cylindrical tanks were redesigned for 0.2 m, 0.4 m and 0.6 m design ice thickness. After further consideration of the various climatological regions of Ontario recommendations will be made for use of one of these three designs.

Service is needed:

1. To publish the results of the ice build-up survey of manure tanks in Southern Ontario.
2) To publish design information that will assist concrete tank designers in Ontario.

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3) TECHNICAL INFORMATION TO ASSIST THE FARM BUILDING INDUSTRY

The Ontario Ministry of Agriculture, Food and Rural Affairs has agreed to assume the co-ordination role for the C.P.S. (Canada Plan Service). This will require an on-going effort to maintain the existing CPS data resources and support the development of new plans and technical leaflets. The farm construction industry requires technical information on several topics; chimney design for natural ventilation, diaphragm bracing for post frame construction, the use of laminated posts, and information regarding tunnel ventilation for combating animal heat stress. The industry has identified building construction/inspection as an area that needs improvement. In particular, building inspection across the province is not uniform and courses should be mandatory for building officials to assure their education level.

Service is required:

1. To support OMAFRA's effort to maintain the existing CPS data resources and promote the development of new plans and technical leaflets.
2. To develop a design leaflet for chimney design for naturally ventilated livestock buildings.
3. To write a Factsheet regarding tunnel ventilation for livestock and poultry.
4. To write a Factsheet regarding wind forces on farm buildings.

5. To ensure that training/upgrading courses are available for building officials and building contractors so that uniformity of building construction/inspection takes place.
6. To place C.P.S. leaflets and plans in electronic format on the current website for download by clients.

PROPOSED SUB-COMMITTEE MEMBERSHIP FOR 2001 LIVESTOCK ENGINEERING SUB-COMMITTEE

Organization	Name	Contact Information	Term End
OMAFRA	John Johnson (Chair)	OMAFRA, 667 Exeter Rd. LONDON, ON N6E 1L3 Ph. 519-873-4096 Fax 519-873-4062	Passed due
Univ. of Guelph	Dr. Jan Jofriet	University of Guelph, School of Engineering, GUELPH, ON NIG 2WI Ph. 519-824-4120 Ext. 3642 Fax 519-836-0227	2001
Private Sector	Jim Cooke	R.R.#1 Walkerton, ON N0G 2V0 Ph. 519-881-1188 Fax 519-881-3628	2001
vate Sector	Fred Groenestege	Fred Groenestege Const. Ltd. R.R.#1, SEBRINGVILLE, ON N0K 1X0 Ph. 519-393-6579 Fax 519-393-6532	2001
AFRA	Dr. Neil Anderson	Manager, Health Management OMAFRA 2nd Floor, Wellington Place, R.R.#1 FERGUS, ON N1M 2W3 519-846-0965 Fax 519-846-8101	2002
Shur-Gain Agresearch	Bob Robson	R.R.#3, Burford, ON N0E 1A0 Ph. 519-424-2550 Fax 519-424-2570	2002
Private Sector	Dale Thompson	BSM Farm Equipment	2003
Private Sector	One of: David Waud (Sun North), Murray Gould or Paul Fallis (BSM Agri. Ltd.)		2004
Private Sector	One of: Ray Jacobs, (Landmark Builders) or Ron MacDonald (Agviro Inc.)		2004

RURAL ENVIRONMENT ENGINEERING

SUBCOMMITTEE

Report

TO

ONTARIO AGRICULTURAL AND FOOD

ENGINEERING RESEARCH AND SERVICES

COMMITTEE

December 7, 2000

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LIST OF ACRONYMS

AAFC	Agriculture and Agri-Food Canada
ARIO	Agricultural Research Institute of Ontario
CARC	Canadian Agri-Food Research Council
CC	Canada Committees
CPS	Canada Plan Service
CURB	Clean Up Rural Beaches
EFP	Environmental Farm Plan
LICO	Land Improvement Contractors of Ontario
MCCR	Ministry of Consumer & Commercial Relations
MNR	Ministry of Natural Resources
MOE	Ministry of Environment
OAFERSC	Ontario Agricultural and Food Engineering Research and Services Committee
OFEC	Ontario Farm Environmental Coalition
OMAFRA	Ontario Ministry of Agriculture, Food, and Rural Affairs
UG-AC	University of Guelph Alfred College
UG-RC	University of Guelph Ridgetown College
SPOF	Strategic Plan for Ontario's Fisheries
SWEEP	Soil and Water Environmental Enhancement Program
UTRCA	Upper Thames River Conservation Authority

1.0 EXECUTIVE SUMMARY

The Rural Environment Engineering Subcommittee presents this minor report to the Ontario Agriculture and Food Engineering Research and Services Committee (OAFERSC). The committee recognizes the new procedures to be followed and also that this year the Food Program is the major area of review. Issues related to Food Program are to be forwarded to the appropriate committee for consideration.. The Rural Environment Engineering Subcommittee primarily focussed on last years report and evaluated whether there were any new more pressing issues to address before the next major review and what the progress has been made on the research recommendations from the previous year.

Air and water quality (more specifically groundwater quality) and water quantity are the major issues to be addressed within the rural environment area. Increased pressure from the public and other government agencies is pushing the agricultural sector to continue to increase activity in the air and water quality areas from a research and technology transfer standpoint.

The following emerging needs were identified:

- Municipal Nutrient Management and Interim Control Bylaws to Control Development of Large Livestock Operations
- Community Resentment Towards the Establishment of Large Swine Operations
- An accelerated Rise in Public Scrutiny, Interest, and Activity in ground water quality and contamination. Primarily is focussed on bacteria but likely to progress to nitrates in the future.
- Application of biosolids on agricultural land is receiving increased scrutiny with equal attention as livestock manure.
- Large Water Systems regulations require well head studies which are likely to lead to well head protection plans and likely to be restrictive to some agricultural activities. Small Water Systems are under review as well. Consultations are completed and results are being reviewed. Further regulations are being considered.
- Municipal Waste Water Treatment Systems At Capacity and Looking at Less Costly Alternatives - Phosphorous Offset Methods.
- Drought Conditions Have Passed but Discussions on Water Rights and Allocation Will Continue.
- Greater demand for better weather forecasting and networking for better management of land application of manure and biosolids as well as for surface water supply management.
- Drainage Looked at as Contributor to Low and High Flow Rates in Streams as well as water quality problems.

- Methane - Greenhouse Gas from manure
- Vegetable Wash Water Quality and Legislative Impacts
- Livestock Access to Streams and Conflict with Fisheries Act
- Irrigation Water Quality and Food Safety
- Nutrient Management Plan Bylaw Court Challenges
- Impacts of weather to runoff and infiltration..

Research recommendations were reviewed and adjusted to reflect research needs based on present conditions and emerging needs. The priority recommendations for research and services as identified by the Subcommittee are as follows:

1) To develop improved systems for applying manure to the no-till, hay, and pasture land more accurately, cost effectively, with fewer odours and low risk of movement to tile drains. (R & D)

Research should be oriented towards developing techniques to accurately apply manure both solid and liquid in a cost effective manner on no-till, hay and pasture land. Nutrient management plans are requiring low rates of application and equipment is not available to accomplish the task. Also of great importance is to find techniques of applying liquid manure to tile drained land without risk of manure reaching the drains through macropores.

4) To evaluate and quantify the impact of large livestock operations on the rural environment. (R & D)

A comprehensive study is required to evaluate and quantify the impact on the environment by large livestock operations. Items that must be studied are:

- ☐ volumes of water used and possible impacts on ground water supplies
- ☐ effects of concentration of livestock facilities in an area versus spot development
- ☐ do MDS formulas adequately assess odour potential of large livestock units
- ☐ odours from the buildings
- ☐ odours from the manure storage
- ☐ odours from spreading large volumes of manure
- ☐ impact of manure transport on public roads
- ☐ ability to handle large quantities of manure and the time required

3) To investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land. (R & D)

This project involves an examination of various manure treatment options with the specific goal of reducing odour levels at the barn and storage. It is especially aimed at liquid swine manure systems, though the suitability for other livestock types should also be considered. Treatment could occur during collection, during transfer to storage, during storage, or some combination. The feasibility of biofilters, mechanical systems, aeration, bacterial and enzyme methods etc. need to be investigated. There are two phases of odour generation to investigate i) from the barn and ii) from the storage. Some of these technologies have been successfully applied to urban and industrial applications. There needs to be a concerted effort to apply these technologies to treatment of livestock manure.

4) To identify sources of microbiological and pathogen related water contamination in agricultural watersheds and put into perspective the various contributors. (R & D)

A comprehensive study is needed to examine all sources of microbiological and pathogen water contamination in agricultural watersheds and put into perspective the relative contributions of the various sources. There should be equal focus on surface and ground water quality. Key indicators would include: E. Coli bacteria, Cryptosporidium, giardia, and other related issues such as hormones, heavy metals, and antibiotics. Practices to consider would include:
a) farm practices such as: tillage, nutrient management, manure storage and spreading, livestock pasturing, crop rotation; and

b) non-farm practices such as road construction and maintenance, rural septic system use, municipal sewage treatment plant scheduled and unscheduled releases, other spills, wildlife, etc.

2.0 INTRODUCTION

This is the 2000 minor report of the Rural Environment Engineering Subcommittee to the Ontario Agriculture and Food Engineering Research and Services Committee (OAFERSC). This report highlights emerging needs and research recommendations in the rural environment area. As well, the services (non-research) recommendations were reviewed.

The committee's focus was on research and extension needs related to the rural environment (soil, water, and air). Issues were addressed from an engineering perspective recognizing that there will be some grey areas which may generate some similar recommendations from other committees especially with the present day pressures and interest related to large livestock operations. These crossover areas should not be looked upon as duplication, but rather as important issues recognized and pursued by two disciplines in a co-operative effort.

Information in this report was provided by subcommittee members representing Colleges of Agricultural Technology, University of Guelph, Agriculture and Agri-Food Canada, OMAFRA, and the private sector.

3.0 SUBCOMMITTEE ACTIVITIES

A meeting of the subcommittee members was held on November 28, 2000 at the Ontario Ministry of Agriculture, Food, and Rural Affairs building in Guelph. The previous years report was reviewed and updated. The University of Guelph Environmental program was reviewed last year making this years efforts primarily focused on reviewing the previous years recommendations and verifying that they were still appropriate to the needs of the time. Recommendations were reviewed and adjusted to meet the requirements of the present situation in the agricultural sector. Animals is the primary focus for this year in alignment with the U of G program reviews.

The views and consensus of the committee are reflected in this report. The majority of committee members were present.

4.0 STATE OF THE INDUSTRY

Soil, water, and air issues related to large livestock operations continue to dominate the agricultural industry. The primary stimulation is the construction of swine barns. The number of large swine and dairy operations are still on the increase . More and more municipalities are passing bylaws to try and control construction in an orderly fashion. Nutrient management plans, days of manure storage, and MDS II requirements are included in most bylaws. Interim control bylaws on large livestock building construction is common awaiting the proposed Agricultural Operations Act by the province. Variations occur when attempts are made to inventory land used for application of manure and guarantee application rates. Local resident organizations are still very vocal and well organized in presenting their concerns and demands. Municipalities are reacting accordingly.

Much attention is still focused on bacteria and nitrates as the primary contaminants in light of the Walkerton situation. Runoff from agricultural lands is being scrutinized from many fronts. Department of Fisheries and Oceans and Environment Canada are now getting involved more directly with situations that may be impacting fisheries in Ontario ie. two incidents in Eastern Ontario where charges have been laid.Demands to protect and create riparian zones along waterways and wetlands is also still on the rise.

Phosphorous loading on streams is still a primary concern in many areas of the province. Many municipal treatment systems are dependent on rivers to assimilate treated waste water from cities and towns. Assimilative capacities of some rivers have reached or are reaching the maximum levels permitted . Municipalities are searching for cost effective alternatives such as "phosphorous trading" or "phosphorous credit" type accounting systems based on improvements to agricultural land and nutrient management techniques. Waterloo region has successfully implemented a financial incentive program in targeted areas to encourage implementation of BMP's in agricultural areas. Wellington County is nearing completion of its first year of a similar Rural Water Quality Program with the main difference that it is county based rather than a targeted watersehd area. Other areas (Lake Simcoe, South Nations etc.) are in the process of also initiating similar programs. The problem still remains as to how to account for water quality improvements (phosphorous) which are hard to measure or take time to appear. Empirical and modelling methods are being developed for the purpose of accounting water quality gains.

The Environmental Farm Plan process went through its seventh full year of operation and distributed close to 2000 workbooks which is consistent with previous years. This program is in jeopardy as it is in its final year of funding and new sources of monies have not been secured. The committee recognizes this program as valuable and important for its accomplishments. Some way should be found for its continuation. The incentive program which provides $1500 towards improvements identified in the Farm Plan is being well used and on the increase. The Rural Water Quality Program in Waterloo implemented a completed Environmental Farm Plan as a requirement of eligibility for the program as has the Wellington County program.

Activity in the tile drainage industry

Activity in tile drainage installation is stable and similar to previous years.

The Department of Fisheries and Oceans, in consultation with stakeholders, has developed a Class Authorization system for the maintenance and repair of existing municipal drains. They, in partnership with local Conservation Authorities, have funded the collection of data to catalogue the fish habitat that currently exists in municipal drains. This information is used to classify each municipal drain into six different categories. As a result, municipal drainage superintendents will be able to receive a "class authorization" for their proposed work, provided they follow the predefined conditions for that drain. This positive development promises to minimize the frequent conflicts between municipalities and environmental agencies in the maintenance and repair of existing municipal drains.

The province has completed a review of their drainage programs. The results will be announced later in that year.

5.0 ACHIEVEMENTS

.1 Publications, Factsheets, Manuals

.2 Educational Courses

- Primary Drainage Contractors Course, Feb. 2000
- Advanced Drainage Contractors Course, March 2000
- Municipal Officials Drainage Course - Apr. 2000
- Concrete Manure Storage Design Course, 2000
- Custom Manure Application Course, 2000
- Pollution Control Course, 2000
- Drainage Superintendents Course, 2000
- Nutrient Management Sessions - 2000 (several)

- Ontario Environmental Farm Plan - 2000 All Ontario.

.3 Reports, Periodicals, Articles

.4 Other

Ontario Rural Wastewater Centre, University of Guelph School of Engineering and Alfred College.

6.0 EMERGING NEEDS

.10 Municipal Nutrient Management and Interim Control Bylaws to Control Development of Large Livestock Operations

Large livestock operations are still on the rise in Ontario. Municipalities are reacting to the concerns of the public at large as well as reacting to bylaws instituted in neighbouring municipalities with the view that if neighbouring bylaws are more restrictive swine barn will move to those areas with less control. Municipalities have been given more responsibilities and power. Some are making full use of it. OFEC released a position paper on bylaw development which has helped to reduce the variability between municipalities but with limited success too date. Bylaws are replacing moratoriums on construction. Nutrient management plans are required in all the new bylaws along with MDS II and minimum storage requirements.

Other variables that are being introduced are inventory of land used for manure spreading, verification of application rate, minimum acreage owned, registration of land to be used for manure application etc. Municipalities are searching for mechanisms to give them more control over the situation. Municipalities are hopeful that the new proposed legislation will address many of the enforcement concerns that cannot be addressed with existing mechanisms.

.12 Community Resentment Towards the Establishment of Large Swine Operations

Resentment towards the construction of large swine producing facilities continue to escalate. Guarantees of no odours, no ground water contamination, and no surface water contamination are being demanded. Rural residents who may not even be adjacent to or near the construction sites get actively involved. Some situations are even proceeding through the courts to challenge the construction and operation of larger swine barns. Recent incidents related to leakage from manure storages into tile drains have "fueled the fires" even further.

.13 An Accelerated Rise in Public Scrutiny, Interest and activity in Non-traditional Components of Water Pollution. Primarily is focussed on pathogens but is likely to progress to nitrates in the future.

Water quantity and quality issues are stimulating people to become more aware of other types of water pollution such as Cryptosporidium, giardia, residual medicines and hormones etc.. As their knowledge base increases so does their suspicions of what else might be out there that could be harmful and/or persistent. In many cases there is a link to agriculture. Nitrate has not been a focus of attention yet but is likely to be in the near future.

.14 Application of Biosolids on Agricultural Land is Receiving Increased Scrutiny with Equal Attention as Livestock Manure.

Biosolids application to farm land is being viewed with the same scrutiny as livestock manure. Public pressure is rising an likely to continue to increase for more monitoring and accountability. The existing Certificate of Approval is considered inadequate and insufficiently enforced.

.15 Large Water System Regulations Require Well Head Studies which are Likely to Lead to Well Head Protection Plans and Likely to be Restrictive to Some Agricultural Activities. Small Water Systems are Under Review as well. Consultations Are Completed and Results are Being Reviewed. Further Regulations are being Considered.

.16 Municipal Waste Water Treatment Systems At Capacity and Looking at Less Costly Alternatives – Phosphorous Offset Methods.

Housing is on the increase once again across much of the province and is putting increased demands on sewage treatment plants and the assimilative capabilities of receiving waters. Technology is not available or affordable to reduce phosphorous levels further necessitating a search for other methods to deal with the situation.

Phosphorous is the key component. If Phosphorous levels in the river can be reduced ie. BMP practices by agriculture, present waste treatment technology can still be used (less costly). Another approach that is being looked at is look at the possibility of increasing river flow. Is their waste in the use of water or is too much water being used upstream ie. Irrigation. These are both major issues for the farm community to face and the pressures will increase as more municipalities face waste treatment expansion and upgrades. Presently, there are four watersheds actively involved in this approach and many more will are forthcoming.

.17 Draught Conditions Have Passed but Discussions on Water Rights and Allocation Will Continue.

Water Response 2000 has been released and is being tested in two locations in the province. This plan outlines the roles and responsibilities of provincial and municipal governments, industry, Conservation Authorities, and the private sector when low water and draught conditions are experienced. Even the dry conditions have passed discussion on Water Rights and Allocation processes are likely to continue.

.18 Greater Demand for Better Weather Forecasting and Networking for Better Management of Land Application of Manure and Biosolids as Well as for Surface Water Supply Management.

Best management practices for manure application indicate that weather should be taken into account to avoid movement of manure into tile drainage systems and to avoid runoff. For this practice to be effective, better forecasting will be demanded. Managing surface water quantities for flood management as well as draught conditions are equally important and very dependent on accurate forecasting.

.19 Drainage Looked at as Contributor to Low and High Flow Rates in Streams as Well as Water Quality Problems.

In the past, drainage has been accused of increasing peak flows in channels. Now it is also being looked as a contributor to low flows in dry periods. Focus is on base flow reductions and reduced ground water recharge. In addition, tile drains are a pathway for contaminants especially manure from spreading practices. The use of tile drainage is being challenged.

.20 Methane - Greenhouse Gas from manure.

As more and more manure is spread on the land, methane is emitted into the atmosphere which threatens the ozone layer. As people look for more reasons why livestock agriculture should not expand, greenhouse affect could be the next front to deal with. Research is already started in Ottawa.

.21 Vegetable Wash Water Quality and Legislation

Concerns have been raised regarding fruit and vegetable wash water and how it is handled. Applying the legislation as it is in place could have serious economic impacts.

.22 Livestock Access to Streams and Conflict with Fisheries Act

The private sector are searching for new mechanisms to meet their expectations of stream water quality. Complaints have been lodged under the Fisheries Act which is federal jurisdiction and charges have been laid. This is an indication that the public is not satisfied with provincial response to complaints of this nature. Under the Fisheries Act it is much easier to verify a charge.

.23 Irrigation Water Quality and Food Safety

Irrigation water quality and food safety is an issue of the future. Limited situations have been encountered in Ontario ie. apple cider contamination. It is a rising issue in the US and is likely to be more important here in Ontario especially with fresh produce and quality of irrigation water that is used.

.24 Nutrient Management Bylaw and Plan Court Challenge

Even though nutrient management planning and bylaws are still in their infancy stages in terms of development, the public is not trusting and in their desire for greater environmental security have challenged the nutrient management approach in the courts. Interest is high from both sides of the issue and could greatly influence the future depending on the ruling.

.25 Impacts of weather to runoff and infiltration.

1999 was a dry year in approximately six locations in the province. Agriculture, urban water supplies, sewage treatment facilities, private water supplies, recreation, power generation, ecological systems were all affected. Reserves are very low. Problems and conflicts are probable for the coming year unless there is an unexpected turn around in the weather patterns. In some areas, it is projected that it will take 3 to 5 years of normal precipitation to get back to normal. Long term impacts have not yet been determined.

7.0 REPORT OF ACTION TAKEN ON PREVIOUS YEAR'S RECOMMENDATIONS

(There are not any responses to report.)

8.0 SUMMARY OF DISTRIBUTION OF RECOMMENDATIONS

To Agencies

RECOMMENDATION	AAFC	ARIO	CC	CARC	OMAFRA	OTHER
Priority I (R&D) To develop improved systems for applying manure to the no-till, hay, and pasture land more accurately, cost effectively, with fewer odours and low risk of movement to tile drains. (p.10)	x	x	x 1			
Priority II (R&D) To evaluate and quantify the impact of large livestock operations on the rural environment. (p. 12)	x	x	x 3			MOEE

Priority III (R&D) Investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land. (p.14)	x	x	x 3			
Priority IV (R&D) To identify sources of microbiological and pathogen related water contamination in agricultural watersheds and put into perspective the various contributors. (p.16)	x	x	x 1			MOEE
Priority V (R&D) To develop a standardized test for manure odour-reducing additives. (Adequately serviced for present) (p.18)	x	x	x 3			

Canada Committees: 1 - Natural Resources 2 - Crops 3 - Animals 4 - Food

9.0 DETAILED RECOMMENDATIONS

RURAL ENVIRONMENT ENGINEERING SUBCOMMITTEE

RECOMMENDATION TO

AGRICULTURE & AGRI-FOOD CANADA, AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO, AND CANADA COMMITTEE ON NATURAL RESOURCES

RESEARCH PRIORITY # I **(1.1 A)**

To develop improved systems for applying manure to the no-till, hay, and pasture land more accurately, cost effectively, with fewer odours and low risk of movement to tile drains. (R & D)

DETAILS:

Research should be oriented towards developing techniques to accurately apply manure both solid and liquid in a cost effective manner on no-till, hay and pasture land. Nutrient management plans are requiring low rates of application and equipment is not available to accomplish the task. Also of great importance is to find techniques of applying liquid manure to tile drained land without risk of manure reaching the drains through macropores.

BACKGROUND:

As livestock operations get larger, a greater land base is needed. Conservation farming especially no-till is becoming more common. Application of liquid manure to these lands is at risk to movement through macropores to tile drains. The same problem arises when applying manure to hay fields and pasture land. The present Best Management Practice to prevent this problem is to pretill the land prior to application of liquid manure which is not acceptable. Equipment and techniques need to be developed to overcome this problem. Also, farmers are under much more pressure to complete nutrient management plans but if they need to apply manure at low rates (less than 4000 gal/ac.), equipment is not available to accomplish this task with the accuracy needed.

Some work has been done in this area recently but it was aimed at accurate application of only liquid manure and it involves dropping manure on the surface. There is also a need to address odour reduction and reduction in nutrient losses during spreading through equipment design changes.

COST/BENEFIT:

Society will gain through better management and nutrient application control. The farmers will gain by being able to implement nutrient management plans and save on fertility costs while still protecting the environment.

RESOURCES:

Waste management specialists would be required for the field scale evaluation and design of manure application systems. An agricultural economist should be consulted to determine what economic gains could be achieved.

RURAL ENVIRONMENT ENGINEERING SUBCOMMITTEE

RECOMMENDATION TO

AGRICULTURE & AGRI-FOOD CANADA - EASTERN REGION, AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO, CANADA COMMITTEE ON ANIMALS AND MOEE

RESEARCH PRIORITY # II (1.2 A)

To evaluate and quantify the impact of large livestock operations on the rural environment. (R & D)

DETAILS:

A comprehensive study is required to evaluate and quantify the impact on the environment by large livestock operations. Items that must be studied are:

- volumes of water used and possible impacts on ground water supplies
- effects of concentration of livestock facilities in an area versus spot development
- do MDS formulas adequately assess odour potential of large livestock units
- odours from the buildings
- odours from the manure storage
- odours from spreading large volumes of manure
- impact of manure transport on public roads
- ability to handle large quantities of manure and the time required

BACKGROUND:

Increased competitiveness in the global marketplace has encouraged the development of very large, highly efficient livestock facilities. One facility can replace 10-20 old "farmsteads" in both animal numbers and corresponding feed requirements and manure production. Communities and involved government agencies are struggling with developing means to encourage the investment and job placements associated with these facilities while ensuring that environmental issues are adequately addressed.

Concerned neighbouring residents request information and assurances but neither are available. Ontario's experience with impacts of large operations is limited. Large swine operations are the primary target of late. This trend is likely to spread to other livestock types in the future.

Also, the water needs of these large operations are such that there may be an impact on neighbouring water user's supplies. Answers should be obtained before water supplies are stressed or depleted.

COST/BENEFIT:

Proper guidelines and possibly rules need to be developed so that communities can feel confident that environmental issues are properly addressed. Ideally, the guidelines or rules should be similar across all communities so that location of facilities can be based on other issues rather than individual community environmental acceptance. Decisions if made now would be based on subjective rather than objective information.

RESOURCES:

This project spans many fields of expertise from waste management specialists to hydrogeologist to rural community advisors.

RURAL ENVIRONMENT ENGINEERING SUBCOMMITTEE

RECOMMENDATION TO

AGRICULTURE & AGRI-FOOD CANADA-EASTERN REGION, AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO, AND CANADA COMMITTEE ON ANIMALS

RESEARCH PRIORITY # III (1.3 B)

Investigate and adapt treatment process methods used in urban and industrial centres to reduce odours from livestock manure and make for a safer product to apply to the land.
(R & D)

DETAILS:

This project involves an examination of various manure treatment options with the specific goal of reducing odour levels at the barn and storage. It is especially aimed at liquid swine manure systems, though the suitability for other livestock types should also be considered. Treatment could occur during collection, during transfer to storage, during storage, or some combination. The feasibility of biofilters, mechanical systems, aeration, bacterial and enzyme methods etc. need to be investigated. There are two phases of odour generation to investigate i) from the barn and ii) from the storage. Some of these technologies have been successfully applied to urban and industrial applications. There needs to be a concerted effort to apply these technologies to treatment of livestock manure.

BACKGROUND:

Livestock manure, like any other biological material, undergoes a breakdown of organic matter by microorganisms. When this happens in anaerobic conditions, such as with traditional liquid manure systems, it results in odours. Proper separation distances to conflicting land uses, good housekeeping practices, and covers on storages are examples of methods farmers have used to reduce odour impacts. These approaches are not enough to satisfy the present day rural population. Manure treatment research has been going on for many years but the focus has not always been odour control - other factors have included: reducing volume, concentrating or changing the form of nutrients, producing methane, etc.

Research is needed to examine methods of odour control practical for use on today's farms, especially targeted at large swine farms with liquid manure.

Composting of liquid manure is one technology that is being investigated and should continue. Others include biological treatment, chemical treatment, methane digestion, use of additives, mechanical aeration, separation in combination with a further treatment step, and dehydration.

COST/BENEFIT:

This research will be of greatest benefit to large operations using liquid manure, especially swine. The viability of the industry hinges on being able to expand and build these specialized units. Better solutions are required than bylaw control which will greatly hinder the competitiveness of the industry.

RESOURCES:

This project needs the cooperation of researchers in waste management, odour control, and economics, as well as livestock specialists, agricultural systems specialists, and livestock farmers. Lab and Farm-scale projects will be needed.

RURAL ENVIRONMENT ENGINEERING SUBCOMMITTEE

RECOMMENDATION TO AGRICULTURE & AGRI-FOOD CANADA-EASTERN REGION, AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO, CANADA COMMITTEE ON NATURAL RESOURCES, and MOEE

RESEARCH PRIORITY # IV (1.4 B)

To identify sources of microbiological and pathogen related water contamination in agricultural watersheds and put into perspective the various contributors. (R & D)

DETAILS:

A comprehensive study is needed to examine all sources of microbiological and pathogen water contamination in agricultural watersheds and put into perspective the relative contributions of the various sources. There should be equal focus on surface and ground water quality. Key indicators would include: E. Coli bacteria, Cryptosporidium, giardia, and other related issues such as hormones, heavy metals, and antibiotics. Practices to consider would include:

a) farm practices such as: tillage, nutrient management, manure storage and spreading, livestock pasturing, crop rotation; and

b) non-farm practices such as road construction and maintenance, rural septic system use, municipal sewage treatment plant scheduled and unscheduled releases, other spills, wildlife, etc.

BACKGROUND:

Research effort in the past has been directed at individual farm practises (such as manure spreading) and examining water quality impacts, then recommending changes in farm practices to reduce the potential for water quality impairment. A considerable amount is known about the water quality impacts of many of these individual farm practices. What is not well understood is the big picture - what the relative contributions are of many activities in a watershed to the overall water quality of the watershed.

In these times of limited financial resources to solve environmental problems we need to be able to target the practices that are having the greatest impact. For example, if the sediment loading in a watershed is unacceptable and if the greatest loadings are caused by poor practices of ditch construction and repair, we should not direct all our efforts toward further reducing soil erosion. Similarly, if the bacteria loadings are found to be split between animal and human sources, we should direct more effort (compared to current levels) into identifying the pathways and preventing the human contributions.

Ultimately, the most useful result of this research would be a comprehensive computer program that would consider many factors and could be used to model loadings and identify most likely sources of contamination and most cost effective education/prevention efforts. Models are in the process of being developed or adopted to the situation and the effort should be further supported.

COST/BENEFIT:

As individual farms grow in size, it is likely that more and more of the blame for reduced water quality will be directed to farmers, whether warranted or not. Municipal controls will become stricter, especially on livestock farming. Being able to avoid some of the speculation on contamination sources and address the real problems may help avoid laws based on more emotion than fact. This could have a profound impact on whether a farm operation can even establish or expand in a given municipality.

RURAL ENVIRONMENT ENGINEERING SUBCOMMITTEE

RECOMMENDATION TO

AGRICULTURE & AGRI-FOOD CANADA-EASTERN REGION, AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO, AND CANADA COMMITTEE ON ANIMALS

RESEARCH PRIORITY # V (1.5 C)

To develop a standardized test for manure odour-reducing additives.(R & D)
(This recommendation is somewhat being serviced by facilities in the U. S. and Quebec)

DETAILS:

This project involves an examination of what evaluation procedures are in place and develop a standardized test procedure to evaluate the effectiveness of these additives. Testing must be "realistic". First level testing may be in small vessels in lab for initial screening process but must also include field scale testing in larger tanks outside where manure is added on a continuing basis through variable seasonal conditions.

BACKGROUND:

Many additives are now on the market-some are enzymes, some are masking agents, some change the pH, some are bacterial in nature, some may be feed additives, and affect digestion, etc. Some work has been initiated in the US by Bundy, some in Montreal by Suzelle Barrington, and some is currently underway by the Prairie Swine Centre. Odours are still identified as the main reason for the resistance to large livestock operations. There is a need to advance the techniques and coordinate the test procedures with other researchers so all products are evaluated in a similar manner. Testimonials are not acceptable.

COST/BENEFIT:

This research will be of to all livestock operations but especially to large the swine operations using liquid manure. In some cases, whether these farms can effectively control odours may determine their ability to expand or establish a new facility in an area as bylaws become more and more restrictive.

RESOURCES:

This project needs the cooperation of researchers in waste management, odour control, and economics, as well as livestock specialists, agricultural systems specialists, and livestock farmers. Farm-scale projects will be needed though lab-scale projects may be appropriate for initial evaluation of manure additives.

10.0 APPENDIX

.1 Terms of Reference

1. To review research work and service programs being carried out in Ontario and elsewhere.

2. To disclose problems that face the agricultural industry and which require investigation.

3. To assess and suggest priorities for new research, development, service and information transfer programs and recommend which programs presently under way should be continued, expanded or terminated.

4. To make recommendations on:

a) planning and conducting co-operative research, development, service and information transfer projects, and

b) dividing and allocating research projects in order to provide co-ordination and to avoid unnecessary duplication between stations.

5. To estimate, where possible, costs involved in the conduct of new programs and to supply cost/benefit information.

6. To recommend, where possible, how monies might be obtained or freed to expand current programs or conduct new programs.

7. To supply a written report, at least annually, to the Agriculture and Food Engineering Research and Services Committee.

8. To participate in the planning and execution of meetings: to share research, development, service and information progress and to determine problem areas that need to be addressed.

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.3 Inventory of Person Years

.4 Coding System

A four part code is used to identify each of the projects outlined herein.

The first part, the roman numeral, identifies the subsection of agricultural engineering to which the project belongs. These subsections are:

I	Energy, Power and Processing
II	Power and Machinery
III	Rural Environment
IV	Structures and Environment

The second part identifies the priority of research:

1.	Very Important
2.	Important
3.	Desirable

The third is a coding number. It indicates a listing order but not necessarily the project's priority within the group.

The fourth is a letter to indicate the level of research in that topic:

A - New topic, no known research.
B - Expansion needed, some research under way.
C - Continue at existing level.
D. - Research complete, reallocate efforts to A or B.

CROPS ENGINEERING

RESEARCH AND SERVICES SUBCOMMITTEE

2000 REPORT TO

ONTARIO AGRICULTURAL AND FOOD ENGINEERING

RESEARCH AND SERVICES COMMITTEE

January, 2001

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LIST OF ACRONYMS

OMAFRA	Ontario Ministry of Agriculture, Food and Rural Affairs
ARIO	Agricultural Research Institute of Ontario
CARC	Canadian Agricultural Research Council
AAFC	Agriculture and Agri-Food Canada
CC	Canada Committees

1.0 EXECUTIVE SUMMARY

The Crops Engineering sub-committee prioritised the emerging issues and separated them into research needs and non R&D needs.

RECOMMENDATION I (RESEARCH): NON COMPACTING FIELD EQUIPMENT

As farm operation have increased in size, farm equipment, combines and tractors have become larger and heavier. Manure spreaders can weigh as much as 14 tons and tractors 20 tons. Soil compaction stunts plant growth causing yield decreases of approximately 20 percent. There has been lots of work done on reducing tractor pressure loads by using dual, radial tires and four-wheel drive. Current management of large tractors can in most cases reduce pressure loads to 6-to10 psi on the ground.

Work is needed to reduce soil pressure caused by farm equipment. Currently tire soil pressures can be quite high for large liquid manure spreaders (48 psi), Combines, rear 10 to 32 psi & front 22 to 37 psi. and grain buggies (48 psi). Research is needed to design new equipment or modify existing designs to reduce soil pressures for, manure & Fertiliser spreaders, combines, grain buggies, etc.

RECOMMENDATION II (SERVICE): RURAL ROADS & TRANSPORTING EQUIPMENT SAFETY

Rural road farm and non- farm traffic is increasing. Farming equipment has increase in size, as a respond to the economic pressures to make farming more cost efficient. Cars and trucks are sharing the road with combines and tractors pulling equipment that fill a good portion of the road. Accidents are occurring with these large equipment and cars and trucks. There are a number of safety issues that need to be addressed urgently by the public and private sector. Lack of visibility is a major cause of many accidents.

- Develop an education and information program to increase visibility of agricultural equipment on public roads in dark or poor lighting conditions.

- Develop standard for the use of lights or reflective tape (similar to type on transport trucks) on farm machinery on public roads for front and rear viewing of other road traffic in low and no-light conditions.

RECOMMENDATION III (RESEARCH): Grain and Forage Processing (Drying)

Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment. Ontario corn used in wet milling and for dry-milled food products does not need to be dried to 15% moisture as both industries mill damp grain (i.e., 18-20% wet basis). Also the development of drying systems has not kept pace with the growing industry in conventional and organic production of alternate crops. Producers are forced to adopt a trial-and-error approach to drying or dehydrating, usually with modified tobacco bulk curing kilns or commercial tray dryers.

- Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment

- Basic research is required to investigate the requirements of drying phyto-medicinals, nutraceuticals and horticultural herbage and root crops (e.g., ginseng, echinacea, garlic).

- Research is needed to design new equipment or modify existing designs to accommodate the new crops

- Research into Low-temperature Storage of Damp Grain

- Designs to reduce cost and energy consumption, while maintaining crop quality during the drying process.

RECOMMENDATION IV: Solid & Liquid Manure plus bio-solids Applicators Ability to Apply Manure & Bio-solids Uniformly on the Land At Desired Rates and odour control.

To develop better application equipment that can apply solid and liquid manure plus bio-solids evenly at target rates specified by a nutrient management plan. All application methods must consider now to reduce odour. This research objective is to reduce the cost of nutrients per unit cost of production, plus reducing the potential of pollution.

- Acquire information that can be used to fine tune the application rates and control odour.
- Identify future research needs in the design of solid and liquid manure plus and Bio-solid spreaders.

2.0 INTRODUCTION

This report is the summary of the discussions held by our sub-committee, on Nov 20, 2000, to discuss and review last year's recommendation and to identify emerging issues in the field of crops engineering. The issues identified were broken down into two categories; those requiring research and development, and those requiring non R&D input. Some requiring non R&D input were to be handled by selected members of the committee within the next year.

3.0 SUBCOMMITTEE ACTIVITIES

During the past year, we have had one meeting of this sub-committee.

At this meeting it was decided to revise recommendations. The major priority would be the two items of Non Compacting Field Equipment and Rural Roads and Transporting Equipment Safety.

4.0 STATE OF THE INDUSTRY

Ontario's agriculture and food industry contributes $25 billion to the provincial economy every year, and employs some 640,000 people. It is Ontario's second largest industry. To remain competitive, farmers must expand and adopt new, more efficient production methods. Some times expanding or new farm operations encounter serious conflict with neighbours.

Farm, rural, environmental and urban groups are studying the issues that put farmers in conflict with their neighbours. In Ontario food production and rural housing in the most part are neighbours. Good neighbours need to trust each other, one way to build trust is by having the agricultural operations do a Nutrient Management Plan.

Currently there is a consultation of the rural community with respect to what can be done to ensure that Ontario has adequate food supply, food safety, environmentally sound farm practices and minimum conflicts.

5.0 ACHIEVEMENTS

Achievements of the Crop Engineering Sub Committee over the past year are listed below.

- Canadian Standards Association establishing standards for Farm P.T.O. generators
- Farm Vechicles & Equipment and the Highway Traffic Act. MTO Nov. 2000.
- Standby Power for Farms:
  - Reference Booklet on *Electrical Energy Disaster Planning Manual* and *Materials* for electrical energy disaster plan in the event of extended power outages and energy shortages/delivery problems.
  - A Generic Safe *Operating Procedures Manual* (SOP) includes instructions on maintenance as well as operations.
  - A summary sheet CheckList that can be attached to the stand-by power system.
  - Slide-set for producers on energy efficiency
  - On Farm Standby & Auxiliary Power Systems Hand book
  - Video : Emergency Generators –Safe Use on the Farm
  - Information CD of On Farm Standby Power
  - Compower Generator computer sizing software
- Canadian Standards Association Technical Committee establishing standards for extremity lighting and equipment visibility
- M669-97 (ANSI/ASAE S279.9 Jul93) Lighting and Marketing of Agricultural Field Equipment on Highways
- M673-99 (ANSI/ASAE S338.4 Nov97) Equipment for Agriculture – Safety Chain for Towed Equipment
- M671 – 99 (ASAE S276.5 Nov97) Slow – Moving Vehicle Identification Emblem
- M675-99 (ASAE S365.3 Jul97) Braking System Test Procedures and Braking Performance Criteria for Agricultural Field Equipment

6.0 EMERGING ISSUES

6.1 Mad Cow Disease and Food Safety - The BSE crisis in Europe has resulted in a 25 % drop in meat prices, which, along with the generalized depression of market volumes, worries exporters. Many scientists believe that humans who catch new variant Creutzfeldt-Jakob Disease (vCJD), the human equivalent of BSE, do so as a result of eating BSE-infected beef. More than 80 people in Britain and two in France have so far died of vCJD. All tests in Austria have so far been negative, as they have been in Sweden and Finland. ***DUBAI, Jan 18 (Reuters)*** **-** Saudi Arabia's beef importers are turning to Australia after the kingdom banned beef and mutton imports from the European Union due to fears of mad cow disease. Saudi Arabia may also turn to New Zealand, South and North America or South Africa to meet its needs.

6.2 New Markets for all Natural Beef - For example Argentina tells the world about its pasture-fed cows. The Argentine government began a worldwide campaign in Germany in order to promote the healthiness and quality of Argentine meat products. "Argentine cows are old fashioned, they only feed on pasture". Argentine cows are only fed with natural pasture, with no supplementation based on animal flours

6.3 ISO 9001 certification of Agricultural Operations - Last November, Los Grobo Agropecuaria became the first farming operation in Argentina to receive ISO 9001 certification for its processes of production and commercialization of agricultural inputs. The globalization of ag markets and of the economy in general demand that the excellence of a company and the recognition of its quality and competitiveness can no longer be based solely on tradition and brand recognition. Today it is necessary to certify that the characteristics of a product or a process are optimal in order to aspire to gain new markets.

6.4 Foods made from Genetically Modified Organisms (GMO) - Segregate Harvest and Storage of GMO Foods?

The controversy swirling around biotech-based crops is creating a great deal of uncertainty about seed purchasing decisions. And it could lead to some fundamental changes in the way you market your crops. Protests about GMO crops will mostly not die down. In real life perception is reality and farmers can grow GMO crops however having a market is some thing else. Farmers are being asked to be market wise when deciding what to grow.

Farmers who decide to grow some GMO crops must be ready to segregate harvest and storage of these crops. This will also mean that companies down the food delivery line like processors will have to segregate also.

StarLink scare may curb Asian appetite for US corn TOKYO, Oct 26 (Reuters) - Controversy over a banned biotech corn called StarLink is casting a cloud over the outlook for U.S. grain exports to East Asia, which accounts for some 50 percent of the U.S. corn export market.

The market effect of the loss of European markets for GMOs may be hard to measure and may be hyped in the media, since most U.S. corn and soybeans still feed domestic livestock. But if the U.S. consumer market gets riled up over GMOs in McDonald's hamburgers and other foods, we've got a problem in the U.S. and in Canada. These are pretty big risks, especially if the economic benefits from GMOs are marginal. And they may be, as *Successful Farming* l report in the Up Front section of its December 2,000 issue?

7.0 REPORT OF ACTION TAKEN ON PREVIOUS YEAR'S RECOMMENDATIONS

Crops Engineering Subcommittee

Research # II.1.1-B

Solid & Liquid Manure plus bio-solids Applicators Ability to Apply Manure & bio-solids Uniformly on the Land At Desired Rates and Control Odour.

Response:

Agricultural Research Institute of Ontario - *only provided responses for new recommendations*

AAFC

GPCRC - No activity

SCPFRC - Resources:

SCPFRC has recently initiated a 3-year project in partnership with Ontario Pork, the Agricultural Adaptation Council, and Nuhn industries to investigate swine manure storage and application methods which conserve nutrients, protect the environment from chemical or biological contaminants, and benefit crop yield through suppression of soil-borne diseases.

8.0 SUMMARY OF DISTRIBUTION OF RECOMMENDATIONS

Crops Engineering recommendation to: Agriculture & Agri-food Canada, Agricultural Research Institute of Ontario, Ontario Ministry of Agriculture, Food and Rural Affairs, Canada Committees and Canadian Agricultural Research Council

Recommendation	AAFC	ARIO	CC	CARC	OMAFRA	OTHER
Priority I (Research) **Non Compacting Field Equipment** Research to design new equipment or modify existing designs to reduce soil pressures for , manure spreaders, combines, grain buggies, etc.	x	x	1,2	x	x	FS
Priority II (Research) **Solid & Liquid Manure plus Bio-solids Applicators Ability to Apply Manure & Bio-Solids Uniformly on the Land and control odour.** Acquire information that can be used to determine the application rates. Identify future research needs in the design of solid and liquid manure applicators.	x	x	1,2	x	x	
Priority III (Research) **Grain and Forage Processing (Drying)** Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment Basic research is required to investigate the requirements of	x	x	1,2	x	x	

drying phyto-medicinals, nutraceuticals and horticultural herbage and root crops (e.g., ginseng, echinacea, garlic). Research is needed to design new equipment or modify existing designs to accommodate the new crops Research into Low-temperature Storage of Damp Grain Designs to reduce cost and energy consumption, while maintaining crop quality during the drying process.						

Canada Committees: 1-Natural Resources 2-Crops 3-Animals 4-Food

FS means Farm Safety And M means Manufacture(s)

9.0 DETAILED RECOMMENDATIONS:

ONTARIO AGRICULTURAL AND FOOD ENGINEERING RESEARCH
AND SERVICES COMMITTEE CROPS ENGINEERING RECOMMENDATION TO:

AGRICULTURE & AGRI-FOOD CANADA,
AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO,
ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS
CANADA COMMITTEES AND CANADIAN AGRICULTURAL RESEARCH COUNCIL

PRIORITY RESEARCH I : NON COMPACTING FIELD EQUIPMENT

Details:
Work is needed to reduce soil pressure caused by farm equipment. Currently tire soil pressures can be quite high for large liquid manure spreaders (48 psi) , Combines, rear 10 - 32 psi & front 22 to 37 psi. and grain buggies (48 psi). Research is needed to design new equipment or modify existing designs to reduce soil pressures for, manure spreaders, combines, grain buggies, fertiliser spreaders etc.

As farm operation have grown, farm equipment, combines and tractors have become larger and heavier. Manure spreaders can weigh as much as 14 tons and tractors 20 tons. Soil compaction stunts plant growth causing yield decreases. There has been lots of work done on reducing tractor pressure loads by using dual, radial tires and four-wheel drive. Current management of large tractors can in most cases reduce pressure loads to 6 to10 psi on the ground.

Background:
In 1992, agricultural tire industry changed their load-inflation pressure tables for radial ply tires toward lower inflation pressures. The new tables extend down to inflation pressures of 6 psi for light loads, instead of the previous lower limit of 18 psi. This came about in an effort to reduce or eliminate 'power hop' of large four-wheel drive tractors. Lower tire inflation pressure increases the footprint of the tire, increases the tractive efficiency and capability of the tire, and decreases soil compaction. It is important that the tire pressure not be too low for the load on the tire. A recent Ohio State University study using four-wheel-drive tractors showed a reduction in compaction when tires were inflated at 6-7 psi rather than at 24 psi. Also, equipment with 2- or 3-foot-wide rubber tracks were almost as effective in cutting down compaction as tractors with the low-pressure tires. Work is needed to reduce soil pressure caused by farm equipment.

Cost Benefit:
Soil compaction is like a silent burglar who steals yields when you've dozed off, says Ohio State agricultural engineer Randall Reeder. Data for 2000 shows that corn yields on compacted plots were 11 bushels per acre lower than in control plots, and that soybean yields on compacted plots were 5.5 bushels per acre lower than in control plots. The yield differences were 7 percent and 12 percent lower than control plots for corn and beans, respectively.

ONTARIO AGRICULTURAL AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEE CROPS ENGINEERING RECOMMENDATION TO:

AGRICULTURE & AGRI-FOOD CANADA,
AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO,
ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS
CANADA COMMITTEES AND CANADIAN AGRICULTURAL RESEARCH COUNCIL

PRIORITY RESEARCH II - GRAIN and FORAGE PROCESSING (Drying)

Details:
Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment. Ontario corn used in wet milling and for dry-milled food products does not need to be dried to 15% moisture as both industries mill damp grain (i.e., 18-20% wet basis). Also the development of drying systems has not kept pace with the growing industry in conventional and organic production of alternate crops. Producers are forced to adopt a trial-and-error approach to drying or dehydrating, usually with modified tobacco bulk curing kilns or commercial tray dryers.

Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment

Basic research is required to investigate the requirements of drying phyto-medicinals, nutraceuticals and horticultural herbage and root crops (e.g., ginseng, echinacea, garlic).

Research is needed to design new equipment or modify existing designs to accommodate the new crops

Research into Low-temperature Storage of Damp Grain

Designs to reduce cost and energy consumption, while maintaining crop quality during the drying process.

Background:
The food grade corn industry in Ontario could potentially expand from its present level of about 2 million bushels up to 20 million bushels or more annually if we develop the varieties and the production system to assure delivery of consistent quality. With the pending release of white and food-grade yellow corn varieties for Ontario conditions, there should be an increased export opportunity for snack food corn products. Brian Doidge has estimated that the potential for expansion may be up to $55 million annually (Source - *Food Grade Corn: Expanding the Industry in Ontario*, a report published by Ridgetown College, University of Guelph, July, 1997). Ontario corn would find wider acceptance in local and global industrial markets if it was assured free of physical and chemical damage.

Cost \ Benefits

In about one out of four or five years, poor harvest conditions necessitate drying regimes that cause unacceptable damage, and this is often not visibly apparent to the buyer. Consequently some industrial buyers prefer to import American corn rather than buy locally. Advanced dryer controls and drying systems would save an estimated $6-8 million annually through only the reduction of fuel energy used to over dry corn, and the minimization of hidden losses in storage and handling.

Resources:

The School of Engineering at the University of Guelph maintains ongoing research in crop drying and storage technology (Drs. R. Brown and L. Otten). Current projects involve aeration and cold-temperature damp corn storage, low-temperature drying control systems and drying guidelines for food-grade corn. At the Ridgetown College campus Helmut Spieser is active in extension of grain drying technology and some research activity. Dr. Judith Fregeau-Reid at ECORC in Ottawa works in the area of corn quality as it relates to milling requirements and also evaluation screening of corn varieties.

ONTARIO AGRICULTURAL AND FOOD ENGINEERING RESEARCH AND SERVICES COMMITTEECROPS ENGINEERINGRECOMMENDATION TO:

AGRICULTURE & AGRI-FOOD CANADA,
AGRICULTURAL RESEARCH INSTITUTE OF ONTARIO,
ONTARIO MINISTRY OF AGRICULTURE, FOOD AND RURAL AFFAIRS
CANADA COMMITTEES AND CANADIAN AGRICULTURAL RESEARCH COUNCIL

PRIORITY RESEARCH III

Solid & Liquid Manure plus bio-solids Applicators Ability to Apply Manure & bio-solids Uniformly on the Land At Desired Rates and Control Odour.

DETAILS:

To develop better application equipment that can apply solid, and liquid manure plus bio-solids evenly at target rates specified by a nutrient management plan. All application methods must consider now to reduce odour. This research objective is to reduce the cost of nutrients per unit cost of production, plus reducing the potential of pollution and rural conflict.

1. Acquire information that can be used to fine tune the application rates and odour control.

2. Identify future research needs in the design of solid and liquid manure plus bio-solid spreaders.

BACKGROUND and COST/BENEFITS

If farmers do not voluntarily handle their manure properly then rules may be required to force farmers to do so. Good quality manure application equipment will encourage the farmer to use the manure as a valued nutrient reducing off-farm fertilizer purchases (making the farm more competitive) and reducing environmental losses (making the farm more environmentally acceptable). A "win/win" situation.

In Ontario, an estimated 37 million tons of manure is applied to the land base. This manure 156,000 tons of nitrogen, 79,000 tons of phosphate and 162,000 tons of potash. If fully used to replace commercial fertilizer, it would have a 1995 value of 200 million dollars. Conversely, if not treated properly it could have a negative value as a pollution source. Preliminary research has shown that existing manure application equipment is very difficult to calibrate and does not apply manure evenly across the desired application band.

If better equipment can be developed, farmers will have greater confidence that manure is applied to target areas and they will reduce commercial fertilizer use. This will improve the profitability of the farm and reduce the over application of nutrients lowering possible adverse effects on the environment.

Finally, Ontario is a major manufacturer of manure application equipment. If Ontario develops better technology it is expected that the global demand for our technology will increase. This has the potential for an increase of manufacturing jobs in this field.

Resources

OMAFRA's Engineering and Soil and Crop Specialists are currently working on preliminary projects to develop better equipment.

Husky Farm Equipment, John Deere Welland Works, Agri-Food Labs, Ag Can and OMAFRA have initiated a 4 year MII project to develop precision manure application equipment. See Appendix for update on this project.

DETAILED RECOMMENDATION: Service

RURAL ROADS & TRANSPORTING EQUIPMENT SAFETY

Rural road farm and non- farm traffic is increasing. Farm equipment has increased in size, as a respond to the economic pressures to make farming more cost efficient. Farms are larger than in the past, so operators are forced to travel greater distances on the roadways between fields. Cars and trucks are sharing the road with combines and tractors pulling equipment that fill a good portion of the road. Accidents are occurring with these large equipment and cars and trucks. There are a number of safety issues that need to be addressed urgently by the public and private sector.

Background:

There were over 2,500 farm-related highway accidents in which 842 persons were injured and 33 killed in the last five years according to the Ohio Department of Highway Safety. In Ontario accidents involving tractors in 1992 were 165 accidents 2 deaths, 39 personal injuries and 124-property damage. There are no stats on just farm equipment accidents. Lack of visibility is a major cause of many accidents.

Details:

Develop an education and information program to increase visibility of agricultural equipment on public roads in dark or poor lighting conditions.

Develop an awareness program on the moving of large farm equipment for non farmers and farmers

Develop standards for the use of lights or reflective tape (similar to type on transport trucks) on farm machinery on public roads for front and rear viewing of other road traffic in low and no-light conditions.

APPENDIX

10.1 2001 COMPLETE LIST OF CROPS ENGINEERING RESEARCH AND SERVICES NEEDS:

RECOMMENDATION 1 (SERVICE): RURAL ROADS & TRANSPORTING EQUIPMENT SAFETY

Rural road farm and non- farm traffic is increasing. Farming equipment has increase in size, as a respond to the economic pressures to make farming more cost efficient. Cars and trucks are sharing the road with combines and tractors pulling equipment that fill a good portion of the road. Accidents are occurring with these large equipment and cars and trucks. There are a number of safety issues that need to be addressed urgently by the public and private sector. Lack of visibility is a major cause of many accidents.

1. Develop an education and information program to increase visibility of agricultural equipment on public roads in dark or poor lighting conditions.

2. Develop standard for the use of lights or reflective tape (similar to type on transport trucks) on farm machinery on public roads for front and rear viewing of other road traffic in low and no-light conditions.

RECOMMENDATION 2 (RESEARCH): NON COMPACTING FIELD EQUIPMENT

As farm operation have increased in size, farm equipment, combines and tractors have become larger and heavier. Manure spreaders can weigh as much as 14 tons and tractors 20 tons. Soil compaction stunts plant growth causing yield decreases of approximately 20 percent. There has been lots of work done on reducing tractor pressure loads by using dual, radial tires and four-wheel drive. Current management of large tractors can in most cases reduce pressure loads to 6-to10 psi on the ground.

Work is needed to reduce soil pressure caused by farm equipment. Currently tire soil pressures can be quite high for large liquid manure spreaders (48 psi) , Combines, rear 10 - 32 psi & front 22 to 37 psi. and grain buggies (48 psi,

Research is needed to design new equipment or modify existing designs to reduce soil pressures for, manure and fertilizer spreaders, combines, grain buggies, etc.

RECOMMENDATION 3 (Research) Grain and Forage Processing (Drying)

Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment. Ontario corn used in wet milling and for dry-milled food products does not need to be dried to 15% moisture as both industries mill damp grain (i.e., 18-20% wet basis). Also the development of drying systems has not kept pace with the growing industry in conventional and organic production of alternate crops. Producers are forced to adopt a trial-and-error approach to drying or dehydrating, usually with modified tobacco bulk curing kilns or commercial tray dryers.

Research is needed in new technology for drying equipment suitable for food grade corn drying, and control systems for regulating that equipment

Basic research is required to investigate the requirements of drying phyto-medicinals, nutraceuticals and horticultural herbage and root crops (e.g., ginseng, echinacea, garlic).

Research is needed to design new equipment or modify existing designs to accommodate the new crops

Research into Low-temperature Storage of Damp Grain

Designs to reduce cost and energy consumption, while maintaining crop quality during the drying process.

RECOMMENDATION 4 (Research)

Solid & Liquid Manure plus Bio-solids Applicators' Ability to Apply Material Uniformly on the Land At Desired Rates and Odour Control

To investigate the ability of solid and liquid manure plus bio-solids applicators to spread manure and bio-solids in a uniform coating on the land and with minimum odour. Thereby improving the overall efficiency of nutrient application. This research objective is to reduce the cost of nutrients per unit cost of production, plus reducing the potential of pollution and reduce rural conflict.

Farmers are being encouraged to develop nutrient management plans for their farms and be good neighbours. To do this they need application equipment that will apply manure and bio-solids evenly and at the desired rates and at minimum odour. This is the goal of this research.

Acquire information that can be used to determine the application rates and odour control.

Identify future research needs in the design of solid and liquid manure applicators.

RECOMMENDATION NUMBER 5 No-TILL SYSTEMS

No-till is fast becoming an accepted farming system. Basic and applied information is required to deal with no till and nutrient management issues.

RECOMMENDATION 6 (Research) Site-specific Crop Management

Basic and applied information is required to sustain the precision farming movement. Information is needed to assess for the use of differential global positioning systems data, from yield monitors and crop sensors for site-specific crop management. (not hardware development). Site-specific Crop Management

Research is needed:

Determining the right Interpretation of combine yield maps in terms of subsequent crop nutrient management.

Application of GPS-guided application technology and GIS mapping for spatially-variable input rates needs to be developed.

Long-term research & assessment of the yield effects and sustainability of variable input agriculture is necessary.

RECOMMENDATION NUMBER 7 (Service) Pest Control

To demonstrate alternative Pest Control Measures, which may include; propane flamer, plastic-lined interception ditches, electrical discharge weed control, hot water vegetation control and mechanical pest removal, etc.

Information on these alternative pest control measures needs to be available so producers can effectively evaluate its potential in his system. This technology transfer could include; in field demonstrations, producer workshops, educational videotapes, and factsheets.

Service/Training is needed on:

(a) Performance of alternative pest control measures.
(b) Limitations of effectiveness of alternative control measures.
(c) Understanding the development of the pest and susceptible periods.
(d) Importance of proper environmental conditions for optimum pest control.

RECOMMENDATION NUMBER 8 (Service): SOFT-WARE, MACHINERY MANAGEMENT

There is very little current work in this area. More farmer friendly agricultural computer software is needed that can run on personal computers.

RECOMMENDATION NUMBER 9 (Research) Off Road Emissions

With California introducing emissions standards for diesel engines in January 1986, it will only be a matter of time before standards are demanded for Ontario. Now is the time for industry and government to get involved so that the standards will reflect Ontario Conditions. Research is needed to help in development of these emission standards. Ontario has automobile emission testing program. The question is will there also be one for off road equipment?

RECOMMENDATION NUMBER 10 (Service) Technology Transfer

There are a number of topics where little information is available to the consumers with respect to farm machinery, which have been identified by the committee members.

Growing concern with respect to compaction and the effect of deep versus shallow compaction especially for fine textured soils.

Markers for Sprayers Information in the form of a factsheet describing some of the technical aspects of the markers which also points out the benefits of this device would be useful.

10.1 Complete list of Research and Services Needs in a Priority Listing

Number	
1	(SERVICE) RURAL ROADS & TRANSPORTING EQUIPMENT SAFETY
2	(SERVICE) NON COMPACTING FIELD EQUIPMENT
3	(RESEARCH) GRAIN / FORAGE PROCESSING
4	(RESEARCH) MANURE & BIO SOLID APPLICATION/ODOUR CONTROL
5	(RESEARCH) MINIMUM TILL SYSTEMS
6	(RESEARCH) SITE SPECIFIC MANAGEMENT
7	(SERVICE) PEST CONTROL
8	(SERVICE) SOFTWARE MACHINERY MANAGEMENT
9	(RESEARCH) OFF ROAD EMISSIONS
10	(SERVICE) TECHNOLOGY TRANSFER

10.2 MEMORANDUM TO: Members of the Crops Engineering Research and Services Subcommittee of the O.A.E.R.S.C.

Subject: AGENDA of half day meeting to be held
Monday Nov 20th 2000 at 1:15 P.M to 4:00

The next meeting of the Crops Engineering Research and Services Subcommittee of the OAERSC will take place at *OMAFRA Head office Guelph, Ontario. Corner of Stone and Gordon. In board room 305 on the third floor.*

Please come with a list of emerging issues, problems or concerns that you have, or the organization that you represent have, with respect to agricultural machinery, crop storage and equipment industry.

If you can not attend, please send the above information to me by Nov 15. Thank you.

AGENDA

1:15 pm Introduction

1:30-2:30 Discussion

1. New problems, issues or topics requiring research in the crops engineering area.
2. Identify service programs relative to crops engineering and consider recommendations on the needs for service, and ways to improve present programs and our need for new programs.
3. Review and summarize items 1 and 2 for input into report. (Chairman and secretary to write final copy).

2:30 – 3:15 Review The Ranking of Research and Service items for Enclosure in the 1999 Report

3:15 - 3:30 coffee/donuts)

3:30 – 4:00 Wrap up and action plans

NOTE: Please get in touch with me if you are unable to attend.

Stephen Clarke, P.Eng. Chairperson
OMAFRA, Box 2004,Kemptville, Ont.K0G 1J0.
Telephone: 613/258-8305 or Fax: 613/258-8392.email: sclarke@omafra.gov.on.ca

Enclosed is the 2000 report. Please bring the report to the meeting. Thanks.

10.3 Crops Engineering Committee Membership 2000

Steve Clarke Chairperson Ph: 613-258-8305 Fax: 613-258-8392	Ont. Min. Agr. Food & Rural Affairs ORC Building, Box 2004 Kemptville, On K0G 1J0 Email: sclarke@omafra.gov.on.ca
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Steve Matisz Ph: 519-823-5600 Fax:519-823-8880 1-800-361-8855	Farm Safety Association, 340 Woodlawn Rd.W Suite 22, Guelph, On N1H 7K6 Email: smatisz@farmsafety.ca
Helmut Spieser Ph:519-674-1618 Fax:519-674-1600	Ridgetown College of Agricultural Technology Ridgetown, On N0P 2C0 Email: hspieser@omafra.gov.on.ca
Neil McLaughlin Ph:613-759-1534	Eastern Seed & Oilseed Research Centre Research Branch, Agr. & Agri-Food Canada 2006 Neatby Bldg , 960 Carling Ave., Ottawa, On K1A 0C6 Email: mclaughlinn@en.agr.ca
Finbar Desir Ph:519-826-3549 Fax:519-826-3259	Farm Implements Board OMAFRA, Resources Management Br. 1 Stone Rd W., Guelph, On N1G 4Y2 Email: fdesir@omafra.gov.on.ca
Bill MacGregor Ph:905-734-4501 Fax:905-734-6151	John Deere Welland Works Canal Bank St. Welland, On L3B 3N3 Email: wx20088@deere.com
Innovative Farmers Assoc. Ph:905-729-3254 Fax:905-729-4446	Bob Misener 4760 Haldibrook Rd Caledonia, On N3W 2G8 ph/fx 905-679-3251/6292 email
Ralph Brown Ph: 519-824-4120(3922) Fax:519-836-0227	School of Engineering Univ. of Guelph Guelph, On N1G 2W1 Email: rbbrown@uoguelph.ca
Vacant Ph: 905-841-6888 Fax:905-841-1214	Ontario Retail Farm Equipment Dealers Association,Box 430, 64 Temperance St Aurora, On L4G 3L5
Ontario Soil and Crop Improvement Association Ph: 519-846-5874 Fax:519-846-9378	Paul Vogel ph: 613-528-4045 fax: 1048 RR#1, 3995 Lafleur Rd. Apple Hill, On K0C 1B0 Email: mapler@cnwl.igs.net
OCPA Ph:519-837-1660 Fax:519-837-1674	Bill Wagter, Ont Corn Producers Assoc 90 Woodlawn Rd. W Guelph, On N1H 1B2 Email: wagter@linetap.com

Appendix II : Committee and Subcommittee Membership

Ontario Agriculture and Food Engineering Research and Services Committee 2000

Name	Organization	Address	phone/fax/email
Ron Fleming Chair OAFERSC	University of Guelph	Ridgetown College Ridgetown, Ontario N0P 2C0	ph: 519 674 1612 fax: 519 674 1600 rfleming@ridgetownc.uoguelph.ca
Steve Clarke chair: Crops Eng. Subcommittee	OMAFRA	Box 2004, Provincial Bldg. Kemptville, Ontario K0G 1J0	ph: 613 258 8305 fax: 613 258 8392 sclarke@omafra.gov.on.ca
Punidadas Piyasena chair: Food Eng. Subcommittee	Agriculture & Agri-Food Canada	Food Process Engineering Food Research Program 93 Stone Rd West, Guelph, Ontario N1G 5C9	ph: 519 829 2400 x 3147 fax: 519 829 2600 piyasenap@em.agr.ca
John Johnson chair: Livestock Eng. Subcommittee	OMAFRA	667 Exeter Road London, Ontario N6E 1L3	ph: 519 873 4096 fax: 519 873 4062 jjohnson@omafra.gov.on.ca
Jim Myslik chair: Rural Env. Eng. Subcommittee	OMAFRA	ARD, Wellington Place R. R. # 1 Fergus, Ontario N1M 2W3	ph: 519 846 0941 fax: 519 846 8178 jmyslik@omafra.gov.on.ca
George Garland	OMAFRA	Resources & Regulations Branch 1 Stone Road West Guelph, Ontario N1G 4Y2	ph: 519 826 3560 fax: 519 826 3259 ggarland@omafra.gov.on.ca
Ben Hawkins	University of Guelph	Parish Bldg., Kemptville College Kemptville, Ontario K0G 1J0	ph: 613 258 8336 x 458 fax: 613 258 8285 bhawkins@kemptvillec.uoguelph.ca

Name	Organization	Address	phone/fax/email
Lambert Otten	University of Guelph	School of Engineering Guelph, Ontario N1G 2W1	ph: 519 824 4120 x 2430fax: 519 836 0227 otten@net2.eos.uoguelph.ca
Rene Petroski	Ontario Soybean Growers Association	Research and Technology Coordinator Box 119 Chatham, Ontario N7M 5L8	ph: 519 352 7730 fax: 519 352 8983 petroski@soybean.on.ca
Fred Wagner	Ontario Corn Producers' Association	90 Woodlawn Road West Guelph, Ontario N1H 1B2	ph: 519 837 1660 fax: 519 837 1674 fredw@ontariocorn.org
Paul Vogel	Ontario Soil & Crop Improvement Association 519 846 5874 Fax:519 846 9378	RR#1, 3995 Lafleur Rd. Apple Hill, ON K0C 1B0	ph: 613 528 4045 fax: 613 528 1048 vogelseeds@on.aibn.com

FOOD ENGINEERING SUBCOMMITTEE 2000-01

Name	Organization	Address	phone/fax/email
Peter Ateba	Dairy World	ACCL Oakville, ON	Ph: (905) 849-3293 Fax: (905) 845-6179 petera@dairyworld.com
Dave Delevante	Nacan Products Ltd	201 MacDonald Road Collingwood, Ontario L9Y 4J1	Ph: 705-445-1140 x232 Fax: 705-445-9402 dave.delevante@nstarch.com
Bob Fotheringham	Ontario Bean Producers	140 Raney Cres., London ON N6L 1C3	Ph: (519) 652-3566, Fax: (519) 263-3034 rfother@tcc.on.net

Hugh Fraser	OMAFRA Horticultural Research Institute of Ontario	Vineland Station, Ontario L0R 2E0	Ph: (905) 562-4147, Ext. 304 Fax: (905) 562-5933 hfraser@omafra.gov.on.ca
Frank Holmes	ITA, NRC, Dept. of Food Science	University of Guelph, Guelph, Ont., N1G 2W1	Ph: (519) 824-4120 Ext. 3877 Fax: (905)824-6631 frank.holmes@irap.nrc.ca
Susan Iler (seeking replacement)	Ontario Soybean Growers Marketing	Board, P.O. Box 1199 Chatham, Ontario N7M 5L8,	Ph: (519) 352-7730 Fax: (519) 352-8983 siler@ciaccess.com
Diana Iwaniw	Sandwell Inc.,	Suite 100, 1016B Sutton Drive, Burlington, Ontario L7L 6B8	Ph: 905-319-1666 Fax: 905-319-1801 Diwaniw@sandwell.com
Ian MacKinnon	Jamesway Incubator Co., Ltd.,	30 High Ridge Court, Cambridge, Ont., N1R 7L3	Ph: 519-624-4646, Fax: 519-624-5803 ianmack@jamesway.com
Gauri S. Mittal (Past Chair)	School of Engineering,	University of Guelph Guelph, Ontario N1G 2W1	Ph: (519) 824-4120 ext. 2431 Fax: (519) 836-0227 gmittal@uoguelph.ca
Punidadas Piyasena (Chair)	Food Research Program, Agric. & Agric-Food Canada	95 Stone Road West, Box 3650, Guelph, ON N1H 8J7	Ph: (519) 829-2400 Ext. 3147 Fax: (519) 829-2600 piyasenaP@em.agr.ca
Gaurav Tewari	Guelph Food Technology Centre	88 McGilvray St., Guelph, ONTARIO, N1G 2W1	Ph: (519) 821-1246(Ext.5019) Fax: (519) 836-1281 gtewari@uoguelph.ca
Albert Verbeem	Nestle Foodservices	P.O. Box 1800, Douglas Road, Trenton, Ontario, K8V 5S7	Ph: (613) 394-3328 Ext 274, Fax: (613) 394-4712 al.verbeem@ca.nestle.c

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Ping F. Wu	Ansatec	8 Silas Hill Drive, North York, Ontario, M2J 2X9	Ph: (416) 726-6298 Fax (416) 490-6659 pingwu@ansatec.com
Robin L. Williams	Consumer Foods Division, Robin-Hood Multifoods, Inc.	191 Attwell Dr., Unit 4, Etobicoke, Ont., M9W 5Z2	Ph: (416) 675-2541 Ext. 246, Fax: 416-675-6194 robin.williams@robinhood.ca

LIVESTOCK ENGINEERING SUB-COMMITTEE
PROPOSED SUB-COMMITTEE MEMBERSHIP FOR 2001

Organization	Name	Contact Information	Term End
OMAFRA	John Johnson (Chair)	OMAFRA, 667 Exeter Rd. LONDON, ON N6E 1L3 Ph. 519-873-4096 Fax 519-873-4062	Passed due
Univ. of Guelph	Dr. Jan Jofriet	University of Guelph, School of Engineering, GUELPH, ON NIG 2WI Ph. 519-824-4120 Ext. 3642 Fax 519-836-0227	2001
Private Sector	Jim Cooke	R.R.#1 Walkerton, ON N0G 2V0 Ph. 519-881-1188 Fax 519-881-3628	2001
Private Sector	Fred Groenestege	Fred Groenestege Const. Ltd. R.R.#1, SEBRINGVILLE, ON N0K 1X0 Ph. 519-393-6579 Fax 519-393-6532	2001
OMAFRA	Dr. Neil Anderson	Manager, Health Management OMAFRA 2nd Floor, Wellington Place, R.R.#1 FERGUS, ON N1M 2W3 519-846-0965 Fax 519-846-8101	2002

Shur-Gain Agresearch	Bob Robson	R.R.#3, Burford, ON N0E 1A0 Ph. 519-424-2550 Fax 519-424-2570	2002
Private Sector	Dale Thompson	BSM Farm Equipment	2003
Private Sector	One of: David Waud Murray Gould or Paul Fallis	Sun North BSM Agri. Ltd.	2004
Private Sector	One of: Ray Jacobs or Ron MacDonald	Landmark Builders Agviro Inc.	2004

Rural Environment Engineering Subcommittee Membership 2000

Jim Myslik, (Chairman) 519-846-0941 519-846-8178(Fax)	Agriculture & Rural Division, OMAFRA, Wellington Place, R. R. # 1, Fergus, Ontario, N1M 2W3
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